POWER

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Wasting the Finished Product

THERE are wastes and wastes.

And it costs more to waste some things than it does to waste others.

When the miner in the pit kicks aside a pound lump of coal, he wastes twelve or thirteen thousand B.t.u.

When the fireman on the passing locomotive shies a similar lump of coal at a jeering boy, he wastes not only the same number of B.t.u., but the work of the miner in getting it out, and the work of all the hoisting and breaker crews and all who have handled it, and the railroad crews that have hauled it and its proportion of the overhead on all the outfit and machinery required to mine it and prepare it and get it to the point where it is thrown away.

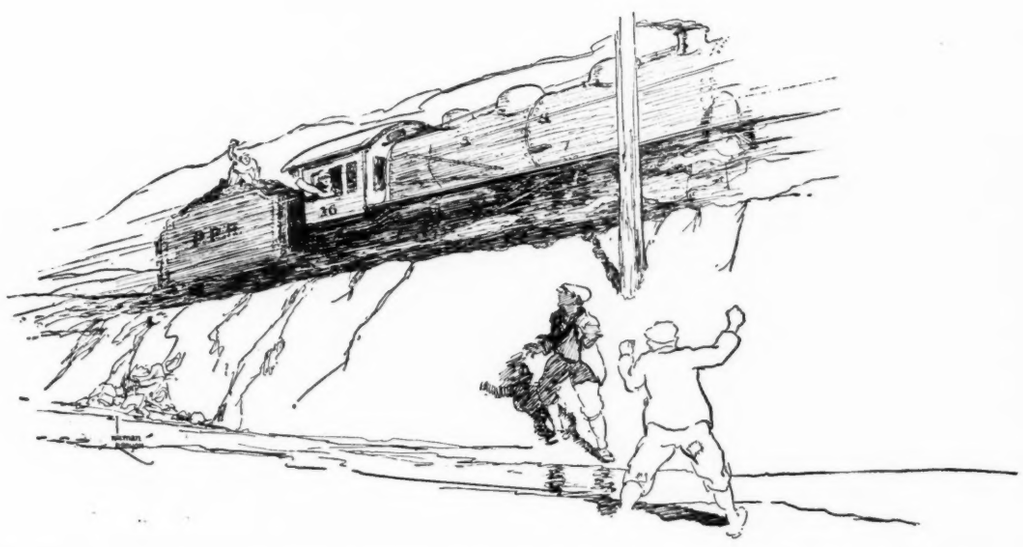
When the stoker wastes a pound of coal, he wastes not only the substance, but all the labor that has brought it to the boiler front. But when the engine wastes a pound of steam, it throws away the product of the coal required to make it, with all the labor and money that have been spent upon it, with all the sacrifice in efficiency which the imperfect methods of its conversion have involved.

And when, by unnecessary friction or wasteful methods of application, power is wasted, there is involved in the waste all the losses, all the lack of efficiency, all the human and mechanical labor and effort and expenditure all along the line.

When we try to heat up the clearance space by compression, we are taking expensive finished product out of the flywheel to perform a function better done by rawer material.

If there is a choice of wastes, let us waste the expensive finished product last of all.

F. R. Low



A 14,000-Kw. Station at Williamsport, Quickly Designed and Built

The ultimate capacity is 160,000 kilowatts. Economizers and stage bleeding are used; with 325 pounds steam pressure. One year after the site was purchased, the design and erection had been completed, with 3,990,500 kw.-hr. generated. A subsequent article will describe some other features of the Williamsport, Md., station.

THE site of the Williamsport Power Station of the Potomac Edison Company at Williamsport in western Maryland, was selected on account of its being near the center of load, and for the availability of water for condensing purposes, especially with regard to the future requirements. None of the company's other plants is capable of any material increase, due to lack of cooling water. The Potomac River and the watershed above this point cover approximately 5,000 square miles. Coal can be delivered both by railroad and canal.

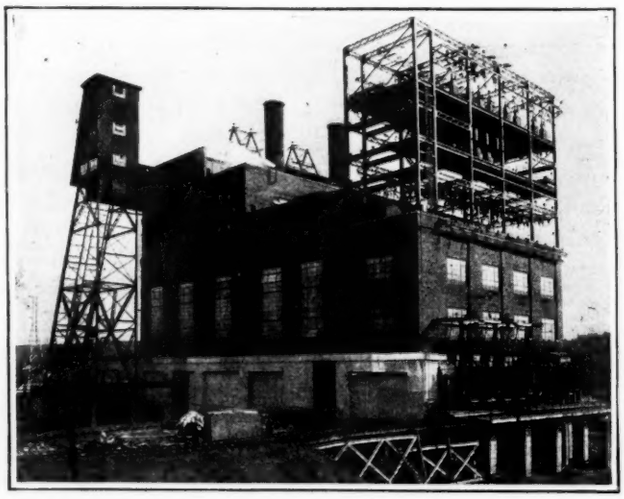


Fig. 1—Operating at full capacity one year after authorizing project

The Potomac Edison Company supplies power to that portion of Maryland west of the Monacacy River, eastern part of West Virginia and Virginia west of the Shenandoah River and Pennsylvania in the vicinity of Marion and Waynesboro. The total population served is 260,000, and the approximate area covered is 35,000 square miles. This company has, in addition to the Williamsport Station, three steam plants of 9,000, and four water-power plants totaling 5,000 kw.

The building design and layout of the plant were not begun until after the purchase of the land. In fact, the exact size of the unit was not definitely settled upon until after the land was obtained.

The site was purchased Aug. 26, 1922, and up to Aug. 26, 1923, the station had generated 3,990,500 kw.-hr. The general design of the building, foundations and all the principal features were made in the New York office of the designing engineers. Only the construction details were worked out in the local office at the plant.

Ground was first broken by the constructors Sept. 11, 1922. To assist in the operations of construction, electric power was supplied from an outside source. The work of turbine erecting was begun June 3, 1923, and cold clearances completed July 13. Five days later the unit was given a run under steam pressure. The heat run was made July 21 and 22. Operation under load was intermittent till July 28 and practically continuous from that time on, supplying a total of 530,000 kw.-hr. by Aug. 1. By Aug. 26, one year after the purchase of the site, 3,990,500 kw.-hr. had been generated. Operation of the unit has been reported as very smooth, so that speed readings on the vibration tachometer are not readily observable.

In the design of this plant it was necessary to take care of a difference of 40 ft. between normal river elevation and the maximum flood condition. The main power-house building is of steel-frame construction. The concrete foundations are carried up to the main turbine and boiler room floor level, which is 6½ ft. above the maximum flood level. The permanent outer walls of the buildings are of red, rough brick. The temporary end walls, which are to be torn down when the plant is extended, are of hollow-tile block construction.

Boilers—Each of the two 14,500-sq.ft. boilers is equipped with an 8,341-sq.ft. economizer and a four-loop superheater located above the main inclined boiler tubes and directly below the horizontal circulating tubes. The guarantees of this boiler, superheater and economizer are given in Table I.

From the observations up to the present time, the boilers are doing better than the guarantees. In this connection one boiler has carried for a short period a station load of 13,000 kw., and it has been found that one boiler will easily carry a continuous load of 10,000 kw. on the station.

Stokers and Clinker Grinders—The boilers are equipped with underfeed stokers having 14 retorts of 23 tuyeres with a single-roll clinker grinder. Stokers and clinker grinders are driven by direct-current motors in order to obtain good speed control.

TABLE I—OPERATING CONDITIONS WILLIAMSPORT BOILER

Predicated on Somerset coal having 14,410 B.t.u. per pound and feed water at 210 deg. F.

Steam output, lb. per hour	40,000	80,000	120,000	160,000
Temp. gas from boiler, deg. F.	465	550	650	750
Temp. gas from economizer	268	322	378	430
Per cent eff. boiler, suphtr. and furnace	79.0	76.2	72.5	68.9
Per cent eff. boiler, suphtr., furn. and econ.	85.0	83.1	80.8	78.6
Feed-temperature rise in econ.	79	96	119	147
Feed temp. to boiler from econ.	289	306	329	357
Superheat	150	200	230	245

Boiler and Economizer Settings—The boilers are entirely steel incased, and each combustion chamber has 6,320 cu.ft. The economizers are also steel incased.

Forced-Draft Fans—Each boiler is equipped with one forced-draft fan. The air ducts of the two boilers are interconnected in order that one fan may be used in an emergency for both or either boiler. Each fan is directly connected to the shaft of a variable speed

Fig. 2—Sept. 29, 1922. Excavating the condenser pit

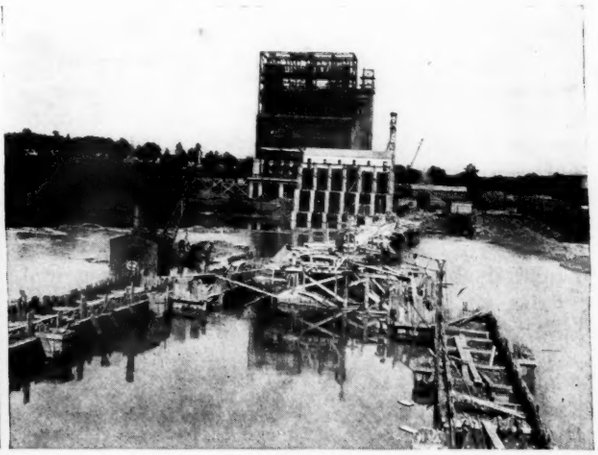


Fig. 5—May 8, 1923. Dam, screenhouse and plant well advanced

Fig. 3— Dec. 31, 1922. Part of condenser pit concreted

Fig. 8—Aug. 5, 1923. In regular service

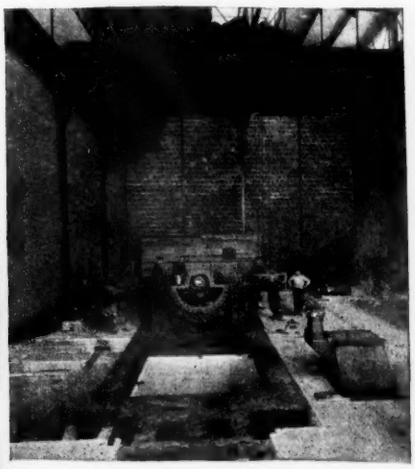


Fig. 6—June 3, 1923. Erecting the 14,000-kw. reaction turbine

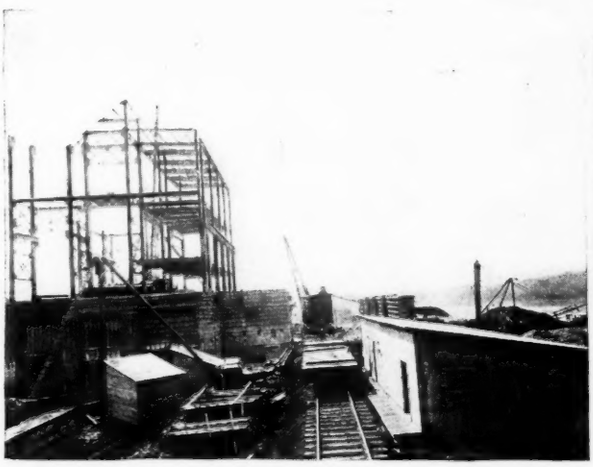


Fig. 4—March 3, 1923. Rushing the steelwork

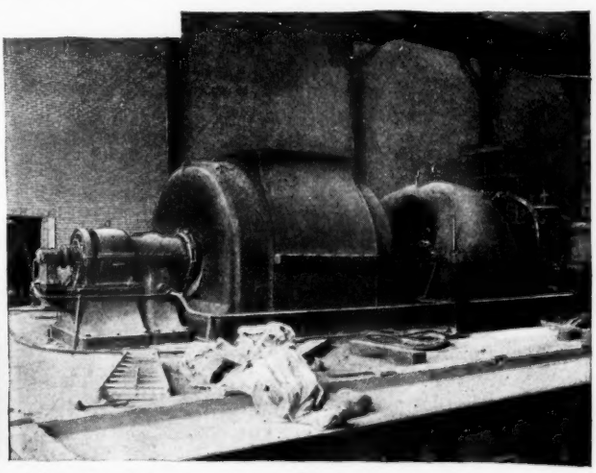


Fig. 7—July 2, 1923. Ready to take clearances

Figs. 2 to 8—Representing Eleven Months of Building Progress Begun Sept. 11, 1922

60-hp. wound-rotor induction motor. This motor is capable of driving the fan at a speed sufficient to produce 120,000 lb. of steam per boiler per hour. The other end of the fan shaft is connected to a 150-hp. variable speed wound-rotor induction motor by means of a magnetic clutch. Should the power requirements of the fan exceed those of the 60-hp. motor, the magnetic clutch is used to connect the larger motor to the fan shaft. This larger motor is capable of supplying sufficient power to the fan to produce 170,000 lb. of steam per boiler per hour.

Induced-Draft Fans—Each boiler is supplied with a double-inlet, double-width induced-draft fan with a dual motor drive similar to that used on the forced-draft fans. The smaller motor, of 60 hp. capacity, is capable of producing sufficient draft for 120,000 lb. of steam per boiler per hour and the larger motor, of 250 hp. capacity, sufficient draft for 170,000 lb. of steam per boiler per hour. The motors for both forced-draft and induced-draft fans are controlled by push buttons on the stoker control boards. These control boards are equipped with position indicators showing which contact of the controller is in use.

No automatic system of draft control has yet been installed, but the electrical control of the forced- and induced-draft fans has been so arranged that this control can be added at any time with the minimum amount of expenditure and changes.

Stacks—Directly from the discharge of each induced-draft fan is one 8-ft. 6-in. diameter unlined, self-supporting steel stack.

Turbo-Generator—The main turbo-generator is a 14,000-kw. unit consisting of a single-flow reaction turbine direct connected to an 18,665-kva. generator running at 1,800 r.p.m. and generating 60-cycle three-phase current at 11,000 volts.

The guarantees of this machine when running without steam extraction are given in Table II. Steam extraction pressures are also indicated.

TABLE II—STEAM CONSUMPTION WITHOUT STEAM EXTRACTION

Also a table of pressures in extraction chamber, with steam at 300 lb. gage 200 deg. F. superheat total temperature 622 deg., 28½ in. vacuum at 75 per cent power factor

Load Kilowatts	Pounds Steam per Kilowatt-Hour	Extraction Pressures, Absolute
7,000	11.75	9.5
8,500	11.40	11.2
10,500	11.00	13.3
14,000	10.50	18.6

The extracted steam is carried into the boiler room to a 465-sq.ft. closed heater through a 12-in. pipe. The water supply of this heater is the condensate pump discharge, and in normal operation the discharge temperature of this heater is in the neighborhood of 140 deg.

Exciters—Directly connected to the main unit is a 90-kw. exciter. In addition there is one 100-kw. turbine-driven exciter.

For Cooling Air Washer—For cooling and cleaning the air used in the main generator there is a water-air washing system that can be used either as a closed recirculating system or as an open system.

Condenser—The condenser is connected to the main turbine by means of a 9-ft. diameter pipe approximately 35 ft. long. In order to allow for expansion, this pipe has, near the turbine, a water-sealed slip expansion joint. The main condenser has 24,000 sq.ft. of surface comprised of 4,868 one-inch tubes. The circulating-water spaces of the condenser shell are divided vertically in order that one half of the condenser may be operated while the other half is being cleaned. It has been found in practice that this arrangement greatly facilitates operation and only a small drop in vacuum is experienced when one-half of the condenser is cut out.

The circulating water for the condenser is supplied by two circulating pumps, each of 15,000 gal. per min. capacity, driven by a 175-hp. constant-speed induction motor. In addition one pump can also be driven by a steam turbine connected to the pump by means of a magnetic clutch. This turbine was installed, as it was felt that in times of line trouble the motors for the circulating-water pumps might fail to function and at these times to maintain a vacuum a steam-driven pump would be necessary. There are two condensate pumps, each of 500 gal. per min. capacity, one driven by motor and one by steam turbine. For air extraction from the condenser there is a Leblanc air pump and also one bank of combined steam-jet air ejectors with intercoolers and aftercoolers. Either of these units is capable of removing the air from the condenser.

Boiler-Feed Pumps—There are two six-stage centrifugal boiler-feed pumps, each having a capacity of 800 gal. per min. and each driven by a steam turbine.

Recirculation of Cooling Water to Melt Ice—The plant is at present arranged so that each condenser will have two circulating pumps and that the two pumps on each condenser will draw their water from different tunnels. This will allow the shutting down of one tunnel for repairs if necessary. In addition one of the intake tunnels is connected to the discharge tunnel by means of a sluice gate in order that this intake tunnel can be used as a discharge tunnel in cold weather to melt any ice adjacent to the intake. Each intake tunnel is provided with one rack, one stationary intake screen and one motor-driven revolving screen.

Open Heater and Deaërator—An open-type wrought-steel-shell feed-water heater is used for heating the feed water and condensing the steam from the steam auxiliaries. This feed-water heater has no water capacity, the water, as it is heated, flowing directly to the deaërator. A flashing type deaërator having a capacity of 225,000 lb. of water per hour is used to extract the air from the water.

A float valve in the deaërator controls a balanced valve on the water line, which supplies the water to the open heater.

Evaporators—There are two submerged coil, high-pressure evaporators. When being operated double effect, they are capable of producing 13,800 lb. of steam per hour. There is a closed condenser between the feed pumps and the economizers for condensing the steam from the last effect. However, should it be found desirable, the steam from the last effect can be sent directly to the open feed-water heater. These evaporators are so piped up that both of them can be operated single effect, which will practically double the output of distilled water should an emergency require it.

Steam is extracted from the turbine when carrying a load of 14,000 kw., at 18 lb. absolute. The extraction steam heats the condensate up to approximately 140 to 150 deg. The water is then further heated to approximately 212 by the steam-driven boiler-feed pumps and any other steam auxiliaries that it is necessary to operate. In this connection the plant is equipped with two atmospheric relief valves on the exhaust-steam piping system, the smaller of which is 8 in. and is set

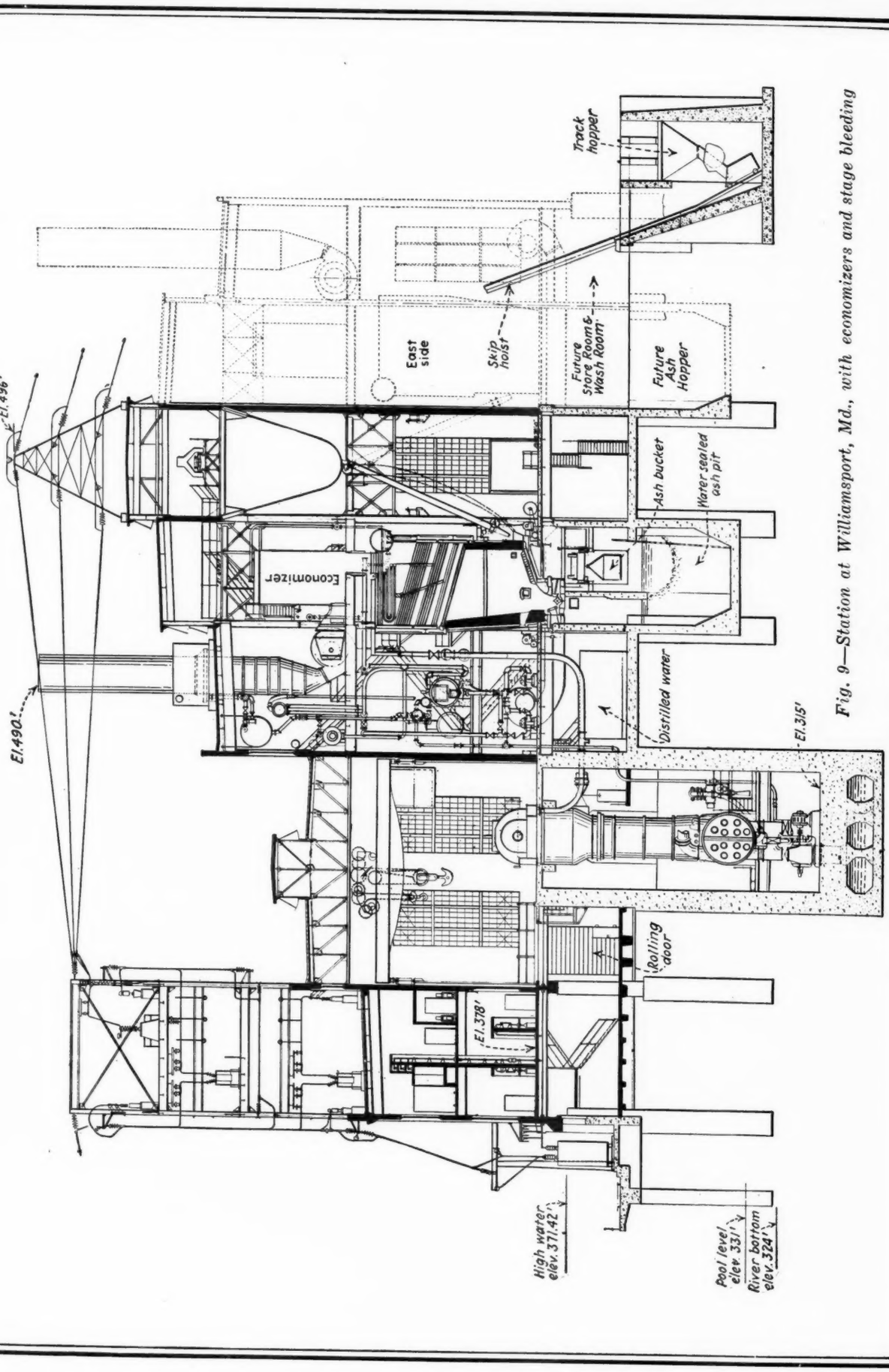


Fig. 9—Station at Williamsport, Md., with economizers and stage bleeding

for ½ lb. back pressure, the larger one being set for approximately 2 lb. back pressure.

The smaller relief line is equipped with a flow meter, the instrument being on the boiler-room floor near the feed pumps. The engineer can then determine the amount of exhaust steam from the auxiliaries, which is being wasted to the atmosphere. Either by controlling the amount of extraction from the turbine or by changing the number of steam auxiliaries in service, the amount of auxiliary exhaust steam wasted to atmosphere can be regulated.

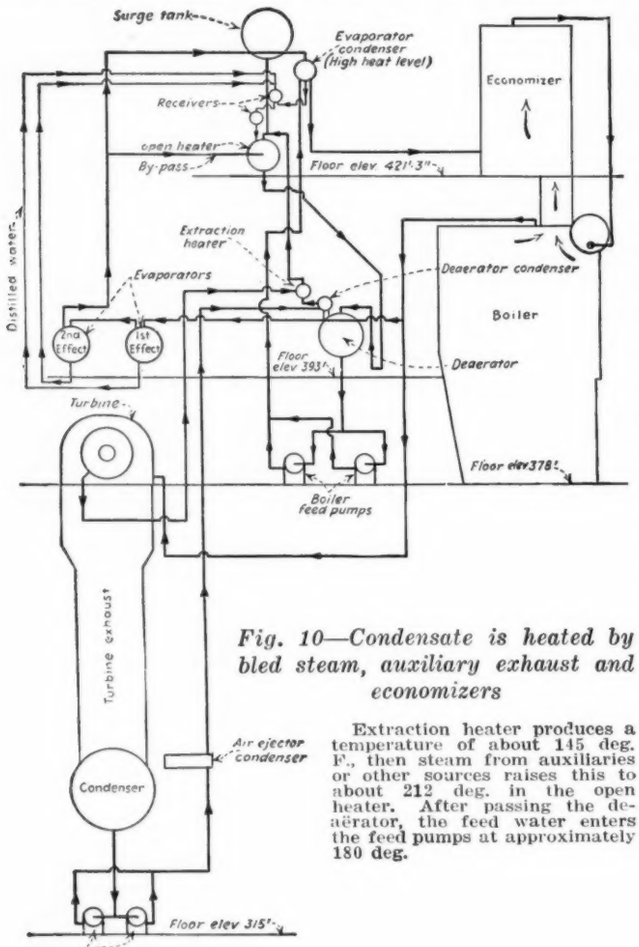


Fig. 10—Condensate is heated by bled steam, auxiliary exhaust and economizers

Extraction heater produces a temperature of about 145 deg. F., then steam from auxiliaries or other sources raises this to about 212 deg. in the open heater. After passing the deaërator, the feed water enters the feed pumps at approximately 180 deg.

It is essential that the water be heated to above 200 deg. in order that the deaërator will fully remove the air from the water, this being necessary on account of the use of forged steel tube economizers. The drop through the deaërator is approximately 20 deg., making the temperature of the feed water entering the feed pumps 180 degrees.

The evaporators are usually worked in series, and there is an evaporator condenser in the feed line just before the economizer. The steam from the last-effect evaporator can be discharged into this condenser or into the open heater, depending on the number of steam auxiliaries that are being run.

Eventually, it is expected to have the steam from the evaporators discharge into the open heater instead of into the closed heater, except in times of emergency, in order to keep down the temperature of the water entering the economizer to approximately 180 deg. The flow diagram, Fig. 10, shows the piping arrangements for obtaining the heat balance on the station.

Intake Above the Dam and Discharge Below—The river being 800 ft. wide at the intake, it was deemed advisable to install a dam approximately five feet above the river bed. This dam is so arranged with stop-log spillways adjacent to the screen chamber, that water is received through the intake from the pool level above the dam and discharged below the dam. The present discharge tunnel is so arranged that it may be used as a future intake, at which time the position of the stop logs will be changed in order that all intake water will be at the pool level above the dam.

Crane—The turbine room is equipped with an electric four-motor crane, the main hoist of 110 tons capacity and the auxiliary hoist of 15 tons capacity.

Piping—All steam piping larger than 4-in. is equipped with Sargol welded joints. Cast-steel valves and fittings were used for all steam and boiler-feed piping.

Coal Handling—The present coal-handling plant contemplates the delivery of coal to the plant in cars. The equipment consists of a track hopper having a total capacity of approximately 75 tons into which the railroad cars are dumped by gravity, as in Fig. 9. The coal from this hopper is taken by a balanced double skip hoist, shown in Fig. 8, the skip tubs having a capacity of three tons each. The skips dump into a hopper in the top of the tower in which the coal-handling machinery is located. From this hopper the coal goes by gravity to a reciprocating feeder and into a crusher. From the crusher it goes on to a 24-in. belt conveyor which passes over a weightometer and is distributed into the main bunker by means of an automatic tripper. The whole coal-handling plant is designed for a capacity of 150 tons per hour. The main bunker has a total capacity of 940 tons.

The skip hoist was selected on account of its first cost, low maintenance and simplicity of operation in comparison to other forms of elevators.

Water-Sealed Ashpit—The ashes from the clinker grinders fall into a water-sealed ashpit (see Fig. 9). This ashpit has a total capacity of 1,150 cu.yd., or 575 yd. per boiler. The ash-handling crane is immediately below the stoker and is a 3-motor crane which carries a 3-cu.yd. bucket. The bucket is in a fixed position on the crane; the latter moving parallel to the boiler fronts, picks the ashes out of the water-sealed pockets. The crane is then moved to the outside of the building and carried on a trestle under which are the railroad cars into which the ashes are dumped for final disposal.

This general scheme of water-sealed ash pockets has been found most satisfactory from both an operating and maintenance viewpoint. The operator is working at all times in a good clear atmosphere, not contaminated by any boiler gases. There is practically no maintenance on any parts of the apparatus with the exception of the ropes that hold the bucket, the bucket itself being of very heavy construction.

Future Capacity, 160,000 kw.—In laying out this plant, the idea has been kept continually in mind that it may be increased to a capacity of 160,000 kw. The present condenser pit has sufficient room for the additional installation of a 30,000-kw. unit. The present discharge tunnel will be used as an intake when the plant is extended, at which time it will be necessary to build a new discharge tunnel further downstream.

This station was built under contract for the Potomac Edison Co. by the American Construction & Securities Co., Sanderson & Porter, designers and supervisors of construction.

PRINCIPAL MECHANICAL EQUIPMENT OF THE WILLIAMSPORT PLANT OF THE POTOMAC EDISON COMPANY

A list of instruments will be included in a subsequent article describing the electrical features of this plant.

BUILDING

Length of boiler room	94 ft. 6 in.
Width of boiler room	79 ft. 0 in.
Length of turbine room and switchhouse	88 ft. 11 in.
Width of turbine room	53 ft. 0 in.
Width of switchhouse	30 ft. 0 in.
Space occupied by building per kilowatt capacity, sq.ft.	1.06
Elevation of condenser pit floor, ft.	315
Elevation of boiler and turbine room basement floor, ft.	358
Elevation of boiler and turbine room main floor, ft.	378
Elevation of economizer floor	421 ft. 3 in.
Low water elevation, ft.	327
Crest of dam and pool level elevation, ft.	331
High water elevation, ft.	371.42

BOILERS, SUPERHEATERS AND ECONOMIZERS

Manufacturer	Babcock & Wilcox Co.
Type—Cross drum boilers—steel encased, Duratex economizers, and Babcock Wilcox superheaters.	
Number of units	2
Steam drum	60 in. diam., 34 ft. 4 in. long
Boiler tubes	4 in. O.D., 42 in. wide, 14 in. high, 20 ft. long
Economizer tubes	2 in. O.D., 22 in. wide, 36 in. high, 20 ft. long.
Number of passes in boilers	3
Boiler-heating surface per boiler, sq.ft.	14,520
Superheater heating surface per boiler, sq.ft.	4,248
Economizer heating surface per boiler, sq.ft.	8,341
Boiler pressure, lb.	350
Economizer pressure, lb.	400
Degrees superheat at 120,000 lb. steam per hour	225

STOKERS AND CLINKER GRINDERS

Manufacturer	Combustion Engineering Corporation
Type	Frederick—Underfeed
Number of retorts	14
Number of tuyeres	23
Projected grate area, sq.ft.	321
Underfeed area, sq.ft.	196
Stoker drive	1 Westinghouse 14 hp. motor—per stoker 300-1,200 r.p.m.
Type of clinker grinder	Single roll
Clinker-grinder drive	2 Westinghouse 5-hp. motors per stoker
Number of stokers per boiler	1
Coal used	Bituminous

BOILER SETTING

Center line drums above boiler-room floor	35 ft. 3 in.
Average height of combustion chamber	17 ft. 0 in.
Width of combustion chamber	24 ft. 10 in.
Volume of combustion chamber, cu.ft.	6,342
Center to center of boilers	40 ft. 0 in.
Distance between settings	11 ft. 8 in.
Width of firing aisle (c. to c. cols.), ft.	25

FORCED-DRAFT FANS

Manufacturer	Green Fuel Economizer Co.
Type and size	No. 6 R.B., double-inlet radial flow
Capacity, cu.ft. per min.	75,000
Number	1 per boiler
Drive	one 60-hp. and one 150-hp. Westinghouse motor per fan
Speed	60-hp. motor, 870 r.p.m., 150-hp. motor, 870-1,160 r.p.m.
Control	Hand control from push button station

INDUCED-DRAFT FANS

Manufacturer	Green Fuel Economizer Co.
Type and size	No. 7½ S.A. double inlet—double width
Capacity, cu.ft. per min	141,800
Number	1 per boiler
Drive	1-60 hp. and 1-250 hp. Westinghouse motor per fan
Speed	60 hp. motor, 0-345 r.p.m., 250 hp. motor, 345-575 r.p.m.
Control	Hand control from push button station

STACKS

Manufacturer	N. Y. Central Iron Works
Type	Steel, self-supporting, unlined
Diameter	8 ft. 6 in.
Height of top above boiler room floor	112 ft. 3 in.
Number	1 per boiler

TURBO-GENERATOR

Manufacturer	Westinghouse
Capacity, kw.	14,000
Voltage	11,000
Type	60-cycle, 3-phase
Speed, r.p.m.	1,800
Steam consumption at full load	28.5 in. vacuum, lb. per kw.-hr. 11.5
Cooling air, cu.ft. per min.	56,000

EXCITERS

Manufacturer	Westinghouse
Type	1 direct connected to main unit; 1 driven by steam turbine
Capacity	Direct-connected, 90 kw., separate 100 kw.
Voltage	250

AIR WASHER

Manufacturer	Cooling Tower Co.
Type	Water Spray-Eliminator
Size	12 ft. 6 in. wide x 7 ft. high x 7 ft. long
Water, gal. per min.	450

CONDENSER

Manufacturer	Westinghouse Electric & Mfg. Co.
Type	Surface, 2-pass.
Tubes	4,868-1 in. diameter, No. 18 B.w.g. Admiralty metal 18 ft. 10 in. long
Condensing area, sq.ft.	24,000
Circulating water at full load, gal. per min.	30,000
Vacuum at full load with 70 deg. circulating water	28.5 in.
Circulating water supply	Potomac River

CIRCULATING PUMPS

Manufacturer	Westinghouse
Type	Centrifugal, double impeller
Number	2
Capacity each pump, gal. per min.	15,000
Speed, r.p.m.	500
Drive	One by 175-hp. motor and one by either 175-hp. motor or Westinghouse turbine through reducing gear

TUNNELS AND SCREEN HOUSE

No. Intake tunnels	2
Total area intake tunnels, sq.ft.	64
No. discharge tunnels	1
Area discharge tunnel, sq.ft.	58
Number of screens	2
Type screens	Motor driven revolving
Area of screened openings, sq.ft.	141

AIR PUMPS AND EJECTORS

Manufacturer	Westinghouse E. & M. Co.
Type	1 bank of compound steam jet air ejectors and condenser (4 ejectors); 1 LeBlanc air pump
Capacity of ejectors in cu.ft. of free air per min.	19.2
Capacity of pump in cu.ft. of free air per min.	11.9

CONDENSATE PUMPS

Manufacturer	Westinghouse
Type	2-stage centrifugal
Number	2
Capacity of each, gal. per min.	500
Speed, r.p.m.	1,750
Drive	One by 75-hp. motor and one by steam turbine

BOILER-FEED PUMPS

Manufacturer	Frederick Iron & Steel Co.
Type	6-stage centrifugal
Number	2
Capacity each pump, gal. per min.	800
Speed, r.p.m.	2,550
Head, lb.	480
Drive	350 hp. Westinghouse steam turbine

HEATERS

Manufacturer	Elliott Co.
Type	1 extraction, condenser type; 1 open, horizontal
Square feet of surface in extraction heater	465
Size of open heater	4 ft. 5 in. diam. x 12 ft. 0 in. long
Source of steam for extraction heater	Bleeding from main turbine
Source of steam for open heater	Auxiliary exhaust

DEAERATOR

Manufacturer	Elliott Co.
Size	6 ft. diam. x 12 ft. 8½ in. long
Capacity lb. of water per hour	170,000 to 255,000

EVAPORATORS (BOILER FEED MAKEUP)

Manufacturer	Griscom-Russell Co.
Number	2
Type	No. 44 Horizontal steel shell, high-pressure Reilly, submerged
Size	5 ft. diam. x 7 ft. 6 in. long, 312 cu.ft. coil surface
Method of operation	Double effect
Pressure, coils, lb.	350
Pressure, 1st-effect shell, lb.	150
Pressure, 2nd effect shell, lb.	100
Capacity—total for both evaps., lb. per hr.	13,800
Source of steam supply	High-pressure steam

EVAPORATOR CONDENSER

Manufacturer	Griscom-Russell Co.
Type	4-pass., high heat level, surface
Number	1
Tubes	¾-in. 16 lb. B.w.g. seamless drawn brass
Pressure, tubes, lb. per sq.in.	480
Pressure, shell, lb. per sq.in.	100
Condensing water	Feed-water discharge from boiler-feed pumps
Drain	Through two G.R. receivers to Elliott open heater

CRANE

Manufacturer	Cleveland Crane & Engineering Co.
Type	4-motor, auxiliary hoist
Load, main hoist, net tons	110

PRINCIPAL MECHANICAL EQUIPMENT OF THE WILLIAMSPORT PLANT OF THE POTOMAC EDISON CO. (Concluded)

CRANE (Concluded)

Load, auxiliary hoist, net tons	15
Span, c. to c. of rails	50 ft. 11 in.
Maximum lift, main hook	52 ft. 0 in.
Maximum lift, auxiliary hook	100 ft. 0 in.
Speed main hoist, ft. per min.	4½
Speed auxiliary hoist, ft. per min.	30
Speed bridge travel, ft. per min.	150
Speed trolley travel, ft. per min.	100
Motors	Westinghouse, 3-phase, 60-cycle, 440-volt
Main hoist motor, hp.	50
Auxiliary hoist motor, hp.	50
Bridge travel motor, hp.	50
Trolley travel motor, hp.	30

ASH-HANDLING TROLLEY

Manufacturer	Milwaukee Electric Crane & Mfg. Co.
Type	3-motor, type D electric traveling trolley
Load, tons	6
Span, c. to c. of rails	6 ft. 9 in.
Lift, ft.	35
Speed, bucket closing, ft. per min.	130
Speed, bucket hoisting, ft. per min.	130
Speed, trolley travel, ft. per min.	350
Drums	2, of 20-in. diam.
Motors	Westinghouse 60-cycle, 3-phase, 440-volt
Bucket closing motor, hp.	50
Bucket hoisting motor, hp.	50
Trolley travel motor, hp.	15
Type of bucket	Clamshell
Capacity of bucket, cu.yd.	3

COAL-HANDLING EQUIPMENT

Track hopper—Skip-filling devices, skip hoist consisting of receiving hopper at top of skip, crusher feeder, crusher, belt conveyor, weightometer and automatic tripper

Manufacturer	Link Belt Co.
Type of track hopper	Steel plate
Capacity of track hopper, tons	75
Number of skip filling devices	2
Capacity of skip filling devices, tons each	3
Number of skip tubs	2
Capacity of skip tubs, cu.ft. each	120
Incline of steel skip guides	23 deg. from vertical
Height of inclined guides, ft.	170
Hoisting motor	Lincoln, 2-speed, 3-phase, 60-cycle, 440-volt
Size of hoisting motor, hp.	50
Type of receiving hopper	Steel plate
Capacity of receiving hopper, tons	16
Type of crusher feeder	Steel plate, reciprocating
Feeder motor, hp.	5
Type of crusher	2 roll
Size of rolls	30 in. diam. by 36 in. face
Crusher motor, hp.	25
Width of belt conveyor, in.	24
Length of belt conveyor, ft.	110
Material of belt	Rubber

COAL-HANDLING EQUIPMENT (Concluded)

Type of tripper	Automatic Standard low-frame, self-propelled complete with two-way discharge chute with flap gate, rail clamps and rotary cleaning brush
Conveyor motor, hp	15
Crusher feeder, crusher and belt-conveyor motors	Westinghouse 3-phase, 60-cycle, 440-volt
Coal weightometer	Merrick Scale Mfg. Co.
Capacity, tons per hour	150

HIGH-PRESSURE STEAM VALVES

Type	Gate
Manufacturer	Chapman Valve Mfg. Co.
Bodies	Extra-heavy cast steel
Mountings	Monel metal
Types	Non-return and globe
Manufacturer	Edward Valve Mfg. Co.
Bodies	Extra-heavy cast steel
Mountings	Monel metal

FEED-WATER VALVES

Type	Gate
Manufacturer	Chapman Valve Mfg. Co.
Bodies	Extra-heavy cast steel
Mountings	Bronze
Types	"Stop and check" and globe
Manufacturer	Edward Valve Mfg. Co.
Bodies	Extra-heavy cast steel
Mountings	Bronze

LOW-PRESSURE VALVES

Type	Gate
Manufacturer	Chapman Valve Mfg. Co.
Bodies	Cast iron
Mountings	Bronze

HIGH-PRESSURE STEAM PIPING

Manufacturer	Benjamin F. Shaw Co.
Pressure, lb. per sq.in.	350
Pipe	Extra-heavy o.h. steel
Fittings	Extra-heavy cast steel
Joints	Van Stone, welded

FEED-WATER PIPING

Manufacturer	Benjamin F. Shaw Co.
Pressure, lb. per sq.in.	450
Pipe	Extra-heavy wrought iron
Fittings	Extra heavy cast steel
Flanges	Screwed and welded to pipe
Joints	Durabla Gasket

LOW-PRESSURE PIPING

Pressure, lb. per sq.in.	125
Pipe	Standard-weight Reading wrought iron
Fittings	Cast iron
Flanges	Screwed
Joints	Durabla Gasket, Durabla Mfg. Co.

Handling Centrifugal Boiler-Feed Pumps

The following is taken from a set of rules for the operation of boiler plant auxiliaries as contained in the Operating Code Manual of the National Electric Light Association.

Starting. 1. See that valve on pressure-gage line on discharge side of pump is open.

2. See that the suction and discharge valves are open.

3. If the unit is steam driven, open drains and exhaust valves, warm up unit.

4. See that all valves to pressure regulator are closed.

5. See that cooling water is on the bearing and seals.

6. Inspect the entire unit's oiling system, seeing that the supply of lubricant is ample and, if of gravity or pressure feed, see that oil is feeding properly to all bearings.

7. Start the turbine or motor slowly and gradually bring up to working pressure.

8. See that the proper pressure is on the equalizing pipes to balance the thrust.

9. Open the steam and water line valves to the pressure regulator.

10. Adjust the regulator to give the proper differential between the feed pressure and the steam pressure.

11. When pumps that are not equipped with a load equalizing device are run in parallel, the load may be equalized by slowing down the speed of the pumps which are taking the most load.

12. Open spray-line valve if the pump becomes steam-bound.

Shutting Down. 1. Shut down the turbine or motor and see that the pump comes to rest.

2. Close the spray-line valve if open.

3. Shut off the oiling system if of pressure or gravity feed.

4. Close the turbine exhaust valve.

5. Close the suction and discharge valves.

6. Shut off the cooling water from the bearings and seals.

7. Close the steam line to the pressure regulator.

8. Adjust the water-line valve to the pressure regulator according to regular practice.

The Shop and Laboratory Committee of the Board of Trustees, Worcester Polytechnic Institute, Worcester, Mass., has recommended the construction of a new $350,000 mechanical engineering laboratory.

Checking the Operation of Hydro-Electric Units

Detecting Lost Motion in Operating-Cylinder Mechanism—Checking Output of Unit—Causes of Reduced Capacity—Scheduling the Work When Unit Is Taken Out of Service for Repairs

BY RALPH BROWN*

THE wide-open position for turbine vanes or nozzles is that opening at which the turbine output is the maximum that can possibly be obtained, and this output is usually obtained at a comparatively low efficiency. Lost motion in the gate-operating mechanism, which will cause a reduction in output due to decreased gate opening, can sometimes be compensated for by increasing the stroke of the operating piston, and if it is found that there is no increase in output from an increase in gate opening above a certain point, the piston stroke should be limited by a stop to that amount. By connecting a steam-engine indicator to the operating cylinder, lost motion can be detected and other data obtained, such as the pressures required to move the vanes to different positions.

An excellent and convenient method for checking the performance of a hydro-electric generating unit is periodically to operate it wide open, recording the kilowatt output, power factor, head and other pertinent data, and comparing the output obtained with standard outputs, which would be those obtained under the same conditions during tests made when the turbine was known to be in good order. In a station where the turbines are operated wide open over a period of hours, the generator watt-hour meter readings will give the truest indication of output, and such outputs can be checked hourly. Where the turbine discharge can be determined by weir measurements, venturi meters or similar means, the kilowatt output of the unit should be periodically checked against the discharge. Even if maximum-output, or economical-output operation is unnecessary, it is advisable to make capacity tests to determine if a possible reduction in output is sufficient to justify an inspection of the interior of the turbine, and it seems that the method of making periodical capacity tests, followed by regular turbine inspections, offers the most effective means of obtaining exact knowledge of the condition of such equipment. In stations where maximum output operation is regularly followed, capacity test data may be copied from the station log sheet; and where turbines are not regularly operated wide open, a form similar to the scheme shown in Fig. 1 will greatly facilitate making of such tests. If the greatest accuracy is required, the power factor of the unit during the test should be maintained at 100 per cent, to avoid the error introduced by the phase angles of the instrument transformers, but this error will be slight at commercial power factors, which rarely are less than 85 per cent at full load. However, with a power factor other than unity, a correction for the generator copper loss must be made.

CAPACITY TEST SHEET

_____Date _____Station

MAIN GENERATING UNITS

Time	Gen. No.	Amperes A.	Amperes B	Amperes C	Volts	Field Amps.	Power Factor	Indicated Kilowatts	Elevations Forebay	Elevations Nozzles	Elevations Head

EXCITER UNITS

Time	Exciter No.	Direct Current Volts	Direct Current Amps.	Direct Current Kw.	Alternating Current Amps.	Alternating Current Kilowatts Gen.	Alternating Current Kilowatts Motor	Total Kw.	Elevations Forebay	Elevations Nozzles	Elevations Head

Capacity tests must be conducted about the first day of each month while station is wide open. Tests should be made when generators are cool, after obtaining sanction of System Dispatcher. After all nozzles are wide open for at least 5 minutes, take readings called for. If only one exciter is in operation, operate motors of other exciters as induction generators.

_____Operator

Fig. 1—Form on which turbine test data are recorded

In plants where economical or maximum operation is followed, the cause of a decrease of 2 or 3 per cent in the output from any generating unit should be ascertained without delay and, if economically advisable, corrected at the earliest opportunity. If a reduction in output is not accounted for by a decrease in head and the generator wattmeter and watt-hour meter is found to be correct, the decreased output must be due to trouble within the turbine, such as excessive leakage through the clearance spaces, a broken or obstructed runner, or to river débris, such as parts of trees, timbers, etc.

*The Great Western Power Company.

interfering with the flow of water through the guide vanes. Considering impulse wheels, a reduction in output will be caused by erosion of the nozzle, lost motion in the nozzle-operating mechanism, and worn or broken buckets, Figs. 3 and 4.

A sudden decrease in output will often indicate a condition that may be remedied by a few hours' work, and such work should generally be undertaken without delay where the setting is such that quick access

REQUEST for EQUIPMENT

_____ 19____ _____ Station

System Dispatcher:
Chief Operator:
It is requested that the equipment named below be taken out of service:

_____

_____

Nature of work to be done:

_____

_____

_____

Safety Card to be issued to _____

Number of men to work under above Safety Card _____

Equipment to be available for workmen _____ A. M. / P. M. _____ 19___

Work will be completed _____ A. M. / P. M. _____ 19____

Mininum time required to return equipment to service _____

This Request for Equipment refers to Trouble Report No. _____

Remarks:

_____

_____

Requested by _____

The equipment named above will be out of service and ready for workmen _____ A. M. / P. M. _____ 19___

Remarks:

_____

_____

_____ 19____ _____ System Dispatcher / Chief Operator

Fig. 2—Form on which request is made for taking equipment out of service

may be had to the interior of the turbine. If the tailrace elevation is above that of the runner, in some plants 24 hours may be required to unwater the turbine casing so that work may proceed, hence it would generally be advisable to postpone the inspection until a Sunday or holiday, or until predicted weather conditions indicate that all the available water can be utilized by the units remaining in service.

When the output of a generating unit gradually decreases to about 95 per cent of normal, the advisability of a thorough overhauling is generally indicated, and after a careful examination confirms this indication, the unit should be taken out of service (after all parts that may require replacement are at hand) at a time when the loss of revenue due to decreased output will be a minimum. The time required to overhaul a hydraulic turbine completely is naturally dependent on many factors, such as the condition of the turbine, its size, type of setting, number of men employed and their experience in this class of work, and may require from a few days to several weeks. In one large Eastern station a bonus is paid to the workmen engaged in such work for each day under a specified time that is saved when a unit is overhauled.

Especially where maximum-output operation is required, and from the viewpoint of good operating practice even where it is not required, it is advisable to schedule all work pertaining to station equipment so that it will be completed as quickly as possible, and it will be found that several classes of work can be efficiently carried on simultaneously, while certain equipment is out of service. As an example, while a generating unit is shut down for inspection of the turbine, additional work, as follows, may be done: (1) Clean trash racks; (2) inspect governor regulating valves, and clean dashpot; (3) clean and inspect collector rings and brushes; (4) clean and inspect generator oil switches; (5) inspect and test relays; (6) clean potential and current transformers; (7) clean generator field rheostat; (8) clean and inspect field switch and field breaker; (9) make repairs to

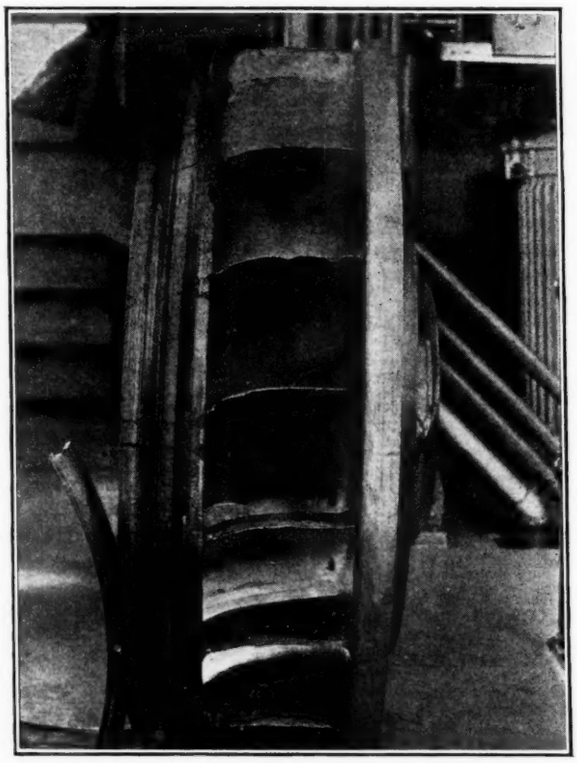


Fig. 3—Shows effects of corrosion on the buckets of a 16,500-hp. Francis wheel operating at 514 r.p.m. under a 460-ft. head

control wiring; (10) make repairs to piping to governors and bearings.

Aside from the saving which will result, by avoiding unnecessary curtailment of output, when maintenance and repair work is scheduled so as to be completed in the briefest possible time, the fact that careful planning of work in connection with generating units, exciters, transformers and transmission lines will greatly increase the time that such equipment will be available for service will prove a decided advan-

tage. While practically all hydro-electric equipment is reliable to a high degree, burnouts and breakdowns sometimes occur. By scheduling all work so that a high service factor $\left(\frac{\text{Hours available for service}}{\text{Total hours}}\right)$ will be maintained, the possibility of the failure of a unit at a time when a generating unit is already out of service for repairs will be greatly reduced.

During periods when economical-output, or maximum-output operation is required, transmission lines should not be taken out of service, for not only will

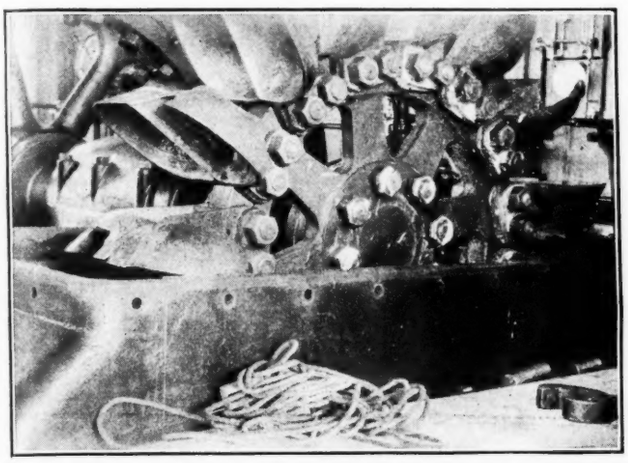


Fig. 4—Shows effects of corrosion on the buckets of a 2,500-hp. Pelton wheel operating at 400 r.p.m. under a 1,000-ft. head

the amount of power available at the substation be reduced, but the transmission-line loss will be increased. If sufficient water and generating capacity is available, the increased losses might be offset by additional generation, but only at the expense of economical-output, or maximum-output operation. Transmission lines, forming, as they do, the weakest link between the generating station and the consumer, should be taken out of service only during off-peak hours, after all contemplated work has been carefully scheduled.

The form shown in Fig. 2 has been devised to facilitate the scheduling of work on a large transmission system, and is filled out, as a request, by anyone qualified to receive a safety card. If filled out by the chief operator or system dispatcher, this form serves as an order for the execution of the work listed.

In installing steam-driven compressors it is essential that steam pipes be amply large to avoid excessive steam pressure drop. Another essential is a steam separator at the compressor steam cylinder entrance; connect this separator drain to a steam trap. Some of the most highly economical steam-driven compressors are built with piston valves, and it is well known that these valves cannot handle slugs of water as freely as the flat type. These piston valves, however, lend themselves to automatic cutoff governor control and to superheat, thus securing high economy. The steam separator is a good piece of insurance when properly drained to a trap; but it is curious to note that separators are sometimes seen without any drain pipe. What mysterious influence the operator attributes to such a device is hard to see.

Steam Boilers

A Catechism by Warren Hilleary Served in Small Doses and Extending Over a Number of Issues

67. In a locomotive type boiler: (a) What is the wrapper sheet? (b) The crown sheet? (c) What is the cylindrical portion of the boiler called? (d) Is the front tube sheet flanged inward or outward, and why?

(a) The sheet which forms the top of the water space over the furnace and the outer side of the water legs. (b) The sheet composing the top of the furnace. (c) The barrel. (d) Outward, for convenience in construction.

68. What is meant by angularity of head to shell braces?

The angle between the brace and the shell to which it is attached.

69. What are gusset stays?

Gusset stays are cut from a piece of boiler plate, are shaped like an unequal right triangle and are used for staying the head to the shell.

70. What is a gusset sheet in a locomotive type boiler?

The gusset sheet is the irregular shaped ring forming a portion of the barrel of the boiler and which either connects the smoke box with the barrel or the barrel with the furnace.

71. What are crown bars in locomotive type boilers?

The bars stiffening the top of the crown sheet and to which the crown-sheet braces are attached.

72. What is the maximum stress allowed on any stay-bolt?

From 6,000 to 7,500 pounds.

73. Which are the longer lived under equal conditions, iron or steel boilers?

Iron, so far as deterioration from pitting and crystallization is concerned.

74. What is a hard patch?

When a defective portion of sheet has been removed and a patch riveted over the opening, it is known as a hard patch.

75. What is a soft patch?

A patch that is riveted over or under a defective portion of plate, the defective portion remaining in place.

76. When would you recommend the application of each?

Hard patches should always be recommended. Soft patches may be used only when it is impossible to apply a hard patch.

77. What objection is there to constructing tubular boilers of but a single sheet?

No objection when they are less than eight feet in length. When the length exceeds eight feet, more than one plate should be used, because then the lapping of the plates at each girth seam serves as a hoop that greatly strengthens the boiler. When a three-sheet boiler is subjected to a hydrostatic test that stresses the metal beyond the elastic limit, the middle sheet bulges between girth seams until it becomes barrel-shaped. The hoop effect of the girth-seam lap is very apparent.

Investigations of Ammonia Condensers*

By T. SHIPLEY†

A CONDENSER may appear to be a very simple apparatus to investigate, but those of us who have gone into the problem seriously, find it quite complicated. At any rate, there are many angles to be considered before a final decision can be reached. It is very easy to make up a lot of theoretical possibilities, but when it comes to producing the results desired, it is often found that the theory needs a lot of adjustment.

One of the requirements of proving a new idea is a practical demonstration. That is why our company is maintaining a Research Department, which prevents many losses, by our trying out a new idea at home instead of on some other fellow's premises. To this end we built an experimental plant in Philadelphia,

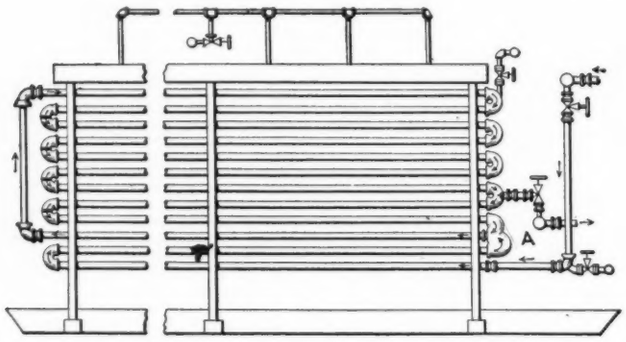


Fig. 1—Flood-type condenser with nozzle

capable of producing 100 tons of ice a day. This plant, known as the Hestonville, was completed in 1922, and we operated it experimentally that year. During 1923 the plant was operated as a commercial plant, our force sending in complete logs every day.

About the time we built this plant, we also equipped a research plant at York, Pa. This plant now contains an equipment that allows us to make investigations on a scale that I believe has never been attempted before in this or any other country. From it we hope to obtain data that will materially assist in the advancement of the arts of ice making and refrigeration.

Our former investigations on ammonia condensers included a large variety of coil and shell types. The results we obtained were very instructive, but when we attempted to put them into general practice, we found that, while we could reproduce our test conditions quite closely when operating at full capacity, there was no dependence when operating below the peak load. A certain number of units working under peak-load conditions would give one result, but if the load was reduced beyond certain limits, the results obtained might or might not follow our adopted curves. The difficulty seemed to be caused by fluctuation in the work done by the individual units, and this fluctuation appeared to be from full to no load; that is, a unit would appear to work for a time and then stop working entirely. This condition would change back and forth from one unit to another for no apparent reason, which action could result only from an uneven distribution of the load. This brought about innumerable changes in devices for the gas inlets and liquid outlets, some of which, for a time at least, would perform quite satisfactorily, while others died at their birth. To attempt to describe the great variety of schemes tried would consume too much space, but in the main they consisted of nozzles and choking devices for the regulation of the flow of gas on the inlet side. To illustrate what is meant, attention is called to Fig. 1, which is a side view of a flooded-type condenser. The nozzle *A* in this condenser distributes the work to the various coils as long as the pressure of the gas entering the nozzle is above that within the condensing section.

Other attempts have been made to steady the performance of condensers by trapping the liquid outlet; in fact, a combination of these devices is generally used. This practice is shown by Figs. 2 and 3, the former being the York standard atmospheric condenser and Fig. 3 shows the bleeder type. The traps of each are at the points *A* where the liquid is taken off the main liquid header. It has been thought that such traps hold sufficient liquid in the condensing sections to distribute the amount of gas entering each of the coils.

It may be possible that some will question the advisability of spending time and money in an effort to reduce the condensing pressure of a plant a few pounds.

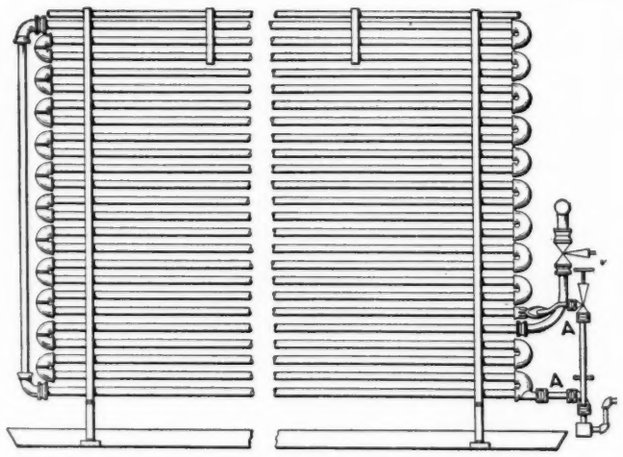


Fig. 2—Standard York atmospheric condenser

However, the saving effected by keeping the condensing pressure as low as possible, is well known to everyone who has had connection with ice-making and refrigerating machinery, but everybody does not keep in mind just what a few pounds, more or less, on the high side will do to the power requirement of a plant. Since improper condenser operation is often the cause of high head pressure, it is worth while to discuss briefly the causes that bring about this unequal working of condensers.

If for any reason the pressure in a coil becomes equal to the pressure in the gas main, the gas flowing

*Extract of paper read before the Annual Meeting of the National Association of Practical Refrigerating Engineers, Dec. 13, 1923, at Memphis, Tenn.

†President, York Manufacturing Company.

into the coil will diminish to an extent sufficient to upset the balance between the coils. This will start the intermittent action and cause the operation of the condensers to become very unsatisfactory. The cause of this building up of pressure in a coil is not hard to understand, now that it is generally accepted that the non-condensable gases found in a condenser are heavier than ammonia gas and, therefore, are found in the bottom of a condensing unit instead of the top. The importance of this fact has not yet struck the minds of all condenser designers, for many are still advocating the placing of gas drums and other devices on the top of condensers, into which they invite the non-condensable gas to take up its lodging. This, however, will hardly take place unless the condenser is shut down, in which case no such device is needed.

To refresh the memory of those interested, attention is called to Table I, which has been taken from a table in general use for some years and which holds true for single-acting compressors.

It will be noted that for every increment of twenty pounds in the condensing pressure there is a considerable increase in the indicated horsepower per ton and that for each suction pressure this increase is about equal for each twenty pounds increase in the condensing pressure.

TABLE I—INDICATED HORSEPOWER PER TON REFRIGERATING DUTY

Condenser Pressure, Lb. Gage	Suction Pressure, Lb. Gage		
	10	20	30
105	1.09	0.80	0.60
125	1.25	0.935	0.72
145	1.40	1.065	0.844
165	1.56	1.201	0.965
185	1.72	1.336	1.085
205	1.879	1.47	1.203
225	2.05	1.609	1.331

If one is operating at 20 lb. gage, suction pressure, and 205 lb. gage condensing pressure, and this pressure is reduced to 165 lb., there will be a saving of 0.27 hp. per ton of refrigeration, or about 0.43 hp. per ton of ice.

Having called attention to some of the important points in ammonia condensers, the development of the design of the Hestonville condenser will be discussed and the reasons for assuming that such a design would give better results than other types of condensers.

In the first place, it was determined, so far as the distribution of the gas was concerned, to treat the condensing of ammonia the same as one would the condensing of steam, and so far as the liquid lines were concerned, these were to be treated the same as a one-pipe heating system. It was decided to use the atmospheric coil type for the condensing unit and take the sensible heat out of the gas by using a preliminary unit, through which the cooling water could be passed on its way back to the cooling tower.

The condensing units were placed under the cooling tower with a vertical shell-and-tube preliminary condenser set up alongside the tower, into which the ammonia gas from the compressor was discharged and through which the water that had passed over the condensing units was pumped on its way to the top of the cooling tower.

The ammonia gas entering the top of the shell of the preliminary unit was cooled and partly condensed. The remaining gas passed out of the preliminary about one-third of the distance from the bottom of the shell, entered the condensing section, and thence down through the pipes in the condensing unit into the receiver, care being taken that there were no traps of any kind in which the liquid could be dammed up, thus doing away with every semblance of choking or trapping.

When the plant was put into operation, this condensing system gave some interesting results. The pressures obtained were unusually low, but the sub-cooling of the liquid was also remarkable, sometimes reaching 10 deg. below the temperature due to the pressure within the condenser. This low temperature, coupled with the low condensing pressure and the fact that there was no evidence of trapped liquid, indicated

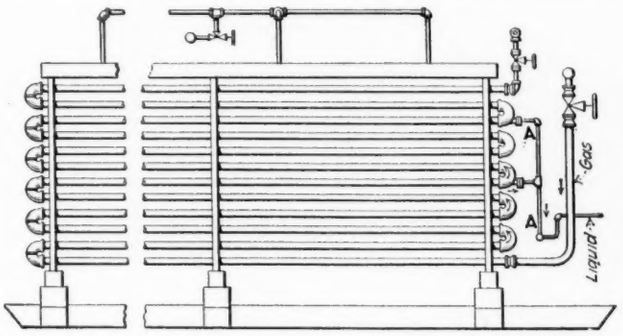


Fig. 3—Bleeder-type ammonia condenser

a very unusual condition and one that required investigation to determine the real cause.

This investigation took several months, for it required many changes in the apparatus, as well as the introduction of new apparatus. Finally, it was concluded that the low condensing pressure was due to the equal distribution of the work made possible by the design of the connections to and from the condensing units and that the low temperature of the liquid was due to its having passed through a non-condensable gas zone.

Then came the proving of this belief, for it was not considered advisable to put this condenser on the market until its efficiency was proved by trying it out on several other plants in another part of the country. To this end, several of the plants built this year were equipped with the Hestonville type of condenser. Men were kept on each of these plants all last summer, and they sent in logs giving all the details of operation to our Research Department. These logs, together with the investigations made with the test plant, satisfied us that there has been produced a condenser that is free of most of the faults met with in the condensers now in general use.

To show the grounds upon which the claims for this condenser are based, attention is called to Table II, which gives a summary of some of the records obtained during the past season from the Hestonville type condenser.

TABLE II—AVERAGE CONDENSER PERFORMANCE, AUG. 1 TO 31, 1923

Location of Plant	Tons Ice per Day	Water Temp. On	Water Temp. Off	Water System	Con. Press Lb Gage
New York City—Huntoon	168.0	74.9	79.9	Cooling tower	152.3
Philadelphia—Hestonville	108.0	71.7	78.0	Cooling tower	142.6
New York City—Ozone Park	159.0	53.0	65.6	Deep-well water	113.0
New York City—E. N. Y. Plant	179.6	55.5	66.2	Deep-well water	116.0
New York City—Bensonhurst	167.7	54.0	66.8	Deep-well water	113.0

The condensing pressures shown in this table are lower than we have heretofore obtained under similar conditions. Every effort has been made to compare these results with other types of condensers in com-

mercial operation, with the result that it is felt that there is no other type that will give the same results.

It may be of interest if the grounds for the belief that the sub-cooling of the liquid leaving the Hestonville condensing units was the result of non-condensable gas in those units, were stated. It is too long a story to attempt to tell in detail, but briefly speaking, it was the result of fixing or locating the condensing zone in the condensing units. This was done principally by studding the return bends with thermometers, and by plotting the readings it was possible to locate definitely the zone where ammonia gas was condensed, the space system with an apparatus devised for that purpose, and by this means it was possible to plot the effect on the general conditions of the condensing system through the several steps needed to remove the air introduced into it.

Fig. 4 shows how the condenser was connected during the investigation and indicates not only how the air was introduced into the system, but also the apparatus used to remove this air while the plant was in operation. In addition to this, it shows the method used to determine the amount of air taken out, as well as the means used to determine the amount of ammonia that the air con-

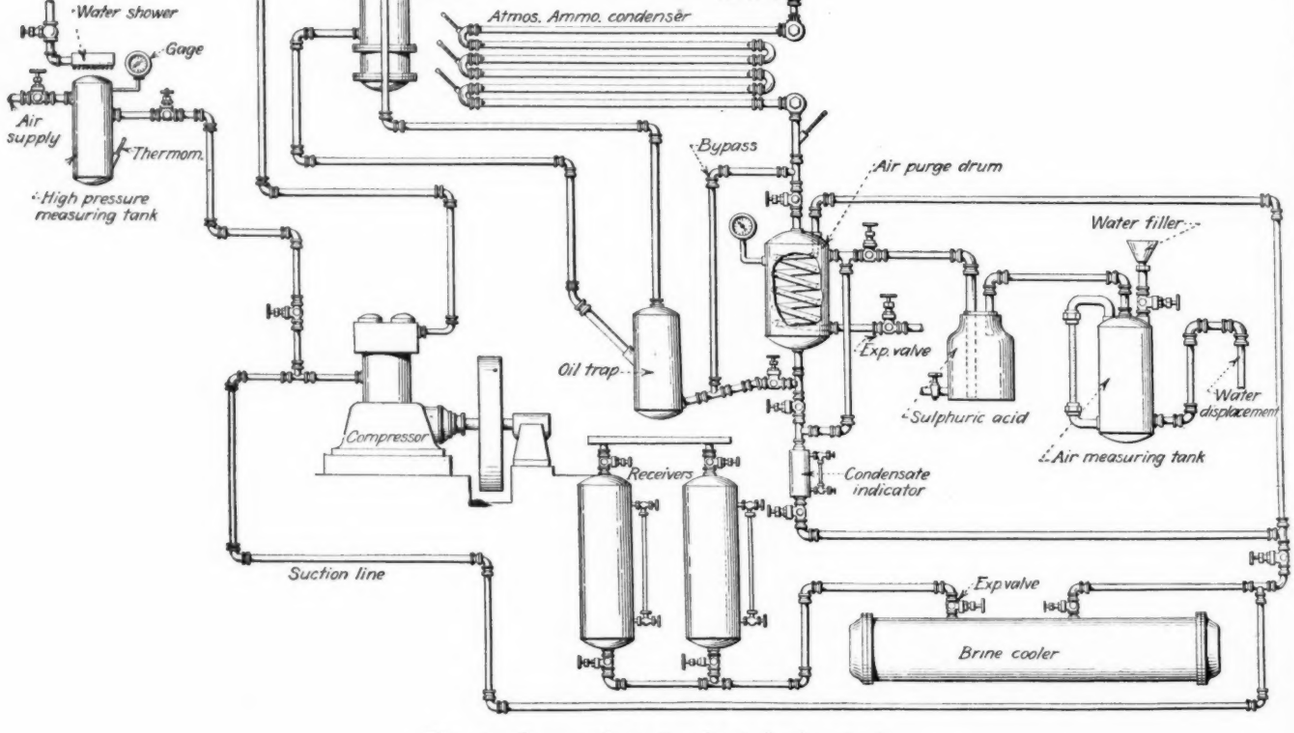


Fig. 4—Connections in plant during tests

in which the non-condensable gas lodged. This latter space is in the lower pipes of the condensing unit. Having located the non-condensable gases, it was not hard to conclude what produced the sub-cooling of the liquid. It was found that the condensation took place in the upper part of the condensing unit and the liquid flowed down through the non-condensable gases, where it was sub-cooled by the water passing over the pipes. This was possible because there was practically no ammonia gas in this part of the condenser.

This deduction has since been corroborated by investigations made at the York test plant. This was done by introducing a definite amount of air into a plant while it was in operation, and carefully noting the effect upon the general conditions of the plant, which were briefly, as follows: The condensing pressure increased, the horsepower per ton increased, and the temperature of the liquid leaving the condenser dropped.

After we had run the plant a sufficient length of time with the air content, the air was drawn out from the tained when it was drawn out, thus determining the ammonia loss.

It was found that the introduction of a volume of compressed air equivalent to 93.3 cu.ft. of free air, jumped the condensing pressure from 147.8 to 183.1 lb. gage, and at the same time the horsepower per ton went from 1.35 to 1.53, while the temperature of the liquid ammonia dropped from 81.5 to 71.3 deg. F. Then as the air was drawn out again, the condensing pressure gradually came back to its original point, as did the other conditions, until, when the air had been practically all removed, the conditions were the same as at the time the air was introduced.

This part of the investigation was very important, and it meant more in the final summary than any other stage of the investigation, for it proved conclusively many things that all were uncertain about before these investigations.

It has been decided that on condensers constructed in the future by the company the following provisions will be made:

1. Condensers will be bled from the bottom instead of the top hereafter, and all connections to and from condensers will be made straight and free of traps.

2. A condenser will be equipped with some means whereby the non-condensable gases can be kept from lodging in the condensing zone.

3. When the liquid leaving the condenser is found to be sub-cooled, it will be assumed that the condenser contains a non-condensable gas.

4. When the temperature of the liquid leaving the condenser is due to the pressure, purging will not be attempted.

5. A daily record of the power required to drive the ammonia compressor, separated from all other power used, will be advocated.

It is believed that the standard condensing pressure with 70-deg. water, can be safely reduced from 185 to 160 lb. and possibly to 150 lb. However, to obtain this low pressure, one must remember that more water and more surface will be needed for the reason that one cannot expect something for nothing; but the investment in extra surface and additional water, will pay a large return.

The investigation of ammonia condensers has not ended. Many things are yet to be determined, such as the effect of atmospheric conditions on the operation of condensers and the most efficient type of condenser to use under the varied conditions met with in commercial operation.

Reflection from a Stoker Arch

By R. C. Warner*

For boiler and stoker work an arch is pictured usually as a roof to the furnace, and its function is to direct the flow of the gases, maintain a high furnace temperature, promote ignition and facilitate combustion. In considering the application of an arch to a chain-grate

Fig. 1—New form of Convex-Concave Arch

stoker, it will be recalled that the chain grate works on the theory of progressive combustion; that is, the coal is carried into the furnace, ignited, coked, the combustible or fixed carbon burned up and the ash continuously dumped into the ashpit. It is apparent that there are three distinct zones of combustion: First, ignition; second, coking; third, burning of the fixed carbon, the last-named being the hottest part of the furnace. It is the reflected heat from this hot part that it is desirable to take advantage of to the fullest extent to get the maximum ignition effect and hence maximum capacity from the stoker.

Rays of heat are reflected from an arch the same as rays of light from a mirror; that is, they follow the law

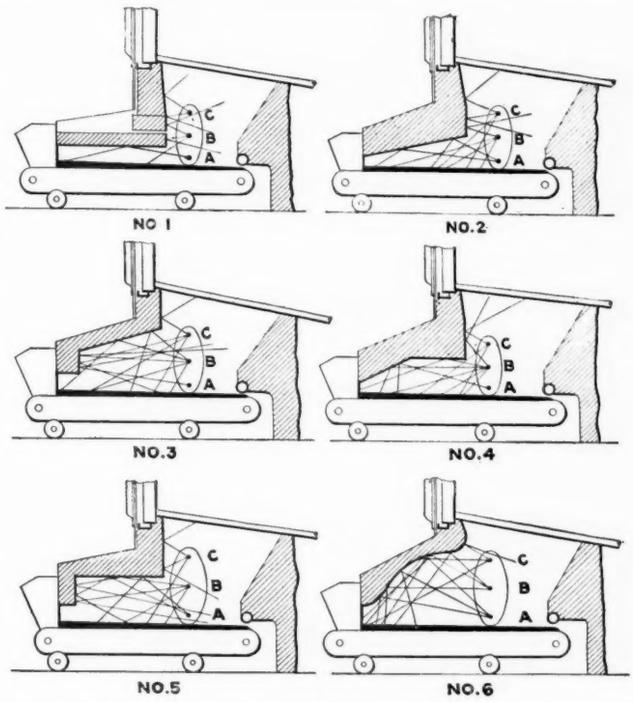


Fig. 2—Reflecto-grams from Six Different Types of Arch

that the angle of incidence equals the angle of reflection. In this connection it will be of interest to see what happens in the furnace of a chain grate set in a standard boiler and equipped with arches of varied contour. Fig. 2 indicates the reflection from six different types of arch. A ring has been placed around the hot zone and three points in this zone, *A*, *B* and *C*, have been selected.

In No. 1 the heat rays from point *A* will reach the incoming fuel, but heat rays from points *B* and *C* cannot get under the arch, so they are lost as far as promoting ignition is concerned. In No. 2 the heat rays from points *A* and *B* are effective, but the rays from point *C* are not. In No. 3 heat rays from points *A*, *B* and *C* are all effective, while in No. 4 it is apparent that only heat rays from points *A* and *B* are effective. In No. 5, while heat rays from points *A* and *B* get under the arch, most of them are reflected away from the incoming fuel. In No. 6 the maximum number of heat rays are reflected onto the incoming fuel.

Sketch No. 6 is representative of the action taking place with a new form of convex-concave arch that has been tried out in service to advantage in the last year or two. Fig. 1 shows one of these arches.

Cylinder condensation is often figured by subtracting the total steam used per hour, as shown by the indicator diagram, from that determined by direct measurement. The difference includes not only cylinder condensation, but valve leakage in the case of engines that do not have separate valves controlling the exhaust.

*District manager, M. H. Detrick Co., Chicago.

Operation and Care of Drum-Type Manual Controllers for Motors

Function of Controller Parts—Adjustment of Contact-Finger Pressure—Movement and Lift of Fingers—Points To Observe When Inspecting Controllers—Cleaning Controllers—Alternating-Current Controllers

BY H. D. JAMES
Manager, Control Engineering Department, Westinghouse Electric & Manufacturing Company

WHEN an electric motor is used for driving apparatus, some form of controller or starter is required. The small motors that are used for domestic appliances are started and stopped by means of a snap switch. Usually, the only automatic feature is the fuse that protects the motor against an abnormal operating condition. Larger motors require more elaborate starters. If the motor has its direction of rotation reversed or requires speed regulation, the controller may become quite elaborate.

The earliest form of controller or starter, and perhaps the one most commonly used today, is of the manual type. This term is commonly applied to a controller that has all its basic functions performed by hand. It is the opposite of power operated or automatic. The manual controller may be complete in itself or may form part of the control equipment, such as a master switch. When a controller is used for accelerating a motor to normal speed in one direction of rotation, it is usually called a starter.

The drum controller is one of the best-known and at present one of the most common forms of manual controllers. When it is used only for reversing a motor, it is known as a drum reverse switch, but it generally has additional points for acceleration and speed control. One type of drum controller is shown in Fig. 1. It consists of a series of stationary fingers *F*, which engage segments *S* on the surface of a cylinder or drum. The cylinder is revolved by a handle and is inclosed in an iron case with a sheet-iron cover. The fingers may be mounted in a single row on one side or in a double row on opposite sides of the drum.

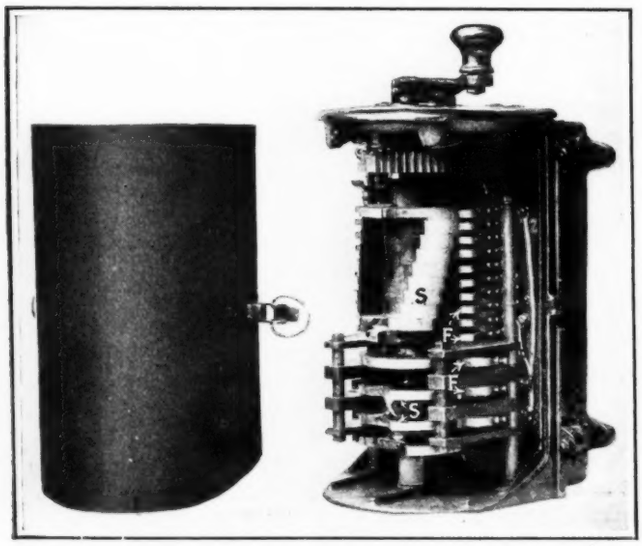


Fig. 1—Drum-type controller with cover removed

The drum cylinder usually consists of one or more castings clamped to an insulated square of hexagonal steel shaft; copper straps are attached to the outer surface for engaging the contact fingers and are sometimes provided with removable arcing tips. In some controllers the drum castings are made of brass or copper and engage the fingers directly without the use of copper straps, but in most cases the drum is provided with removable contact segments.

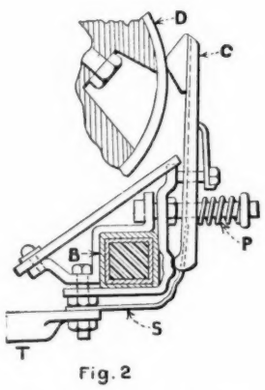


Fig. 2

Fig. 2—Typical type of drum-controller contact finger

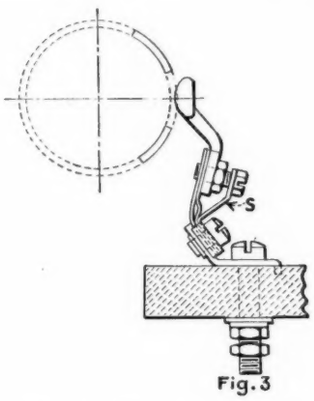


Fig. 3

Fig. 3—Shows controller finger in relation to drum contacts

The most important item in the design of a drum controller is the contact fingers, and many different types have been made and are in successful use today. Each manufacturer has a particular design which he features and which has its advantages and limitations. Fig. 2 shows a type of finger that contains all the elements usually found in the various designs. There is a contact-carrying part *C* which engages with the surface of the drum *D* and is flexibly mounted on a finger base. The pressure between the drum and the finger *C* is maintained by a spring *P*, and the current passes from the finger to the terminal *T* through a flexible shunt *S*. The finger base is securely clamped to an insulated base *B* and is sometimes provided with an arc shield between it and the drum.

When the drum is rotated away from the finger base, the finger is in tension and the operation is easy and natural. When the drum is rotated toward the finger base, the finger is placed in compression and must be rigid enough to withstand the force that is exerted at

the time the contact engages the finger. When the controller is in the off position, the contact fingers project from $\frac{1}{16}$ to $\frac{1}{8}$ in. inside the circumference of the drum, there being no contact straps on this portion of the surface, Fig. 3. A stop *S* on the finger allows a proper adjustment to be made to obtain this condition. When the drum is rotated, the copper strap on the surface of the drum engages the contact fingers at such an angle that it forces the finger back and causes it to

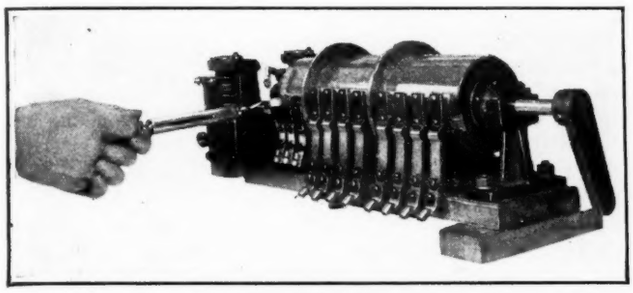


Fig. 4—Method of measuring spring pressure on controller fingers

A stirrup or hook is provided for attachment underneath the contact portion of the finger to which is attached a spring balance. In measuring the pressure do not raise the finger much above the drum surface as this may cause the spring to take a permanent set.

ride over this copper surface. The sliding of the finger on the drum wears it away, and therefore it must be adjusted from time to time in order to maintain the contact pressure.

In moving the drum to the off position, the contact segment moves away from the fingers, forming an arc which is established at one side of the contact surface of the finger and on the edge of the drum segment, so that the burning does not take place on the parts that are ordinarily used for carrying current. A magnetic blowout is frequently supplied with direct-current controllers to extinguish this arc. The blowout may consist of a single coil and common magnetic circuit for all the different fingers, or an individual blowout may be attached to each finger. The latter arrangement gives better results, but its extra expense may not be justified except for heavy duty.

The current that a contact finger will carry depends on the width of the fingers and the pressure between it and the surface of the drum. Tests indicate that if this pressure is in excess of 10 lb. per in. of width, some form of lubricant should be used to prevent excessive cutting. The best form of lubricant is a good grade of vaseline spread thinly over the drum segments. Most controllers are designed for contact pressures less than that given, so that the lubricant is not necessary, although if the drum is kept clean and lubricated, the contact fingers will last longer.

The resistor is usually mounted separate from the drum controller. Where the controller provides for both armature and field control, the resistor for the field rheostat is sometimes mounted as part of the controller. The ordinary reversing controller can be assumed to have separate armature resistors.

All controllers require some attention to maintain them in good operating condition. The following points should be observed when inspecting a drum controller:

1. Alignment—Examine each finger carefully to see that it makes contact over its entire width in all positions of the drum segment which engages it.

The drum segments should be turned true and the contact surfaces be in a straight line, parallel to the axis of the drum.

The portion of the finger that makes contact with the drum should be straight so that when pressed against a flat surface it makes contact over its entire width.

When the drum and finger are both true and even, the finger is ready to mount in place and adjust for alignment throughout its entire width; this adjustment can be easily made by using a wrench to bend the finger.

After adjustment spread grease on the drum segment and move the finger back and forth over this segment several times. The grease will show whether contact is made over the entire width of the finger.

2. Removing burs—Contacts that are subject to arcing become rough and portions of the material are burned away. When inspecting the controller, remove all burns or blisters from the contacts with a file and smooth with fine sandpaper. File the fingers and bevel the approach of the contacts so as to assist the finger in riding over the contact segment.

3. Movement or Lift of Contact Finger—The contact finger should be adjusted so that it drops from $\frac{1}{16}$ to $\frac{1}{8}$ in. below the surface of the drum segment when it is in the open, or off position. If the finger drops too far, there is danger that the drum segment will not lift the finger when it approaches the finger in the direction of support. If the finger is not adjusted far enough below the surface of the drum segment, there will not be sufficient pressure between the contacts to carry the current.

4. Spring Pressure—Drum-controller fingers should be tested for contact pressure. The correct pressure for a paticular design of controller should be obtained from the manufacturers.

The pressure can be measured with a small spring balance as shown in Fig. 4. If the pressure is not sufficient, the spring on the contact finger should be adjusted to obtain the necessary pressure. When in the off position, the spring should cause the finger to exert a positive pressure against its stop. In testing for spring pressure, do not raise the finger much above the drum surface, as this may cause the spring to take a permanent set. If it is necessary to remove the finger to adjust the pressure, it should be adjusted for alignment after being put in place.

5. Cleaning Controllers—In using a cloth or waste for cleaning the controller, be careful that it does not catch in the fingers and pull them back far enough to give the spring a permanent set. Some types of fingers are provided with stops which would prevent this injury, but there are other types in which the movement is not definitely limited by a stop and which might be injured by the careless use of a cloth or waste.

6. Alternating-Current Controllers—Polyphase alternating-current motors have several circuits in parallel both in the primary and secondary. When the load between the phases is properly balanced, each contactor finger will carry its proportionate share of the load. If a contact finger overheats and is found upon examination to be in good condition and properly adjusted, a careful examination of all the connections to the motor and all other contact fingers should be made. A bad connection in some other phase may be responsible for overloading this finger. An ammeter in the motor primary will not show which phase is unbalanced, as the rotation of the secondary causes circulating currents to flow which equalize the load in the primary.

Calculating the Amount of Air Liberated in Barometric Condensers

AIR enters with cooling water, steam and by leakage, which may be easily calculated from charts. In a succeeding article, the author will describe how to select the most suitable type of vacuum pump.

BY C. M. REED*

THE total quantity of air to be removed from a barometric condenser is composed of three parts: (a) Air carried with the steam to be condensed; (b) air liberated from solution in the condensing water; (c) air entering the system by leakage from the atmosphere. These three sources of air entrance into the system will be considered separately.

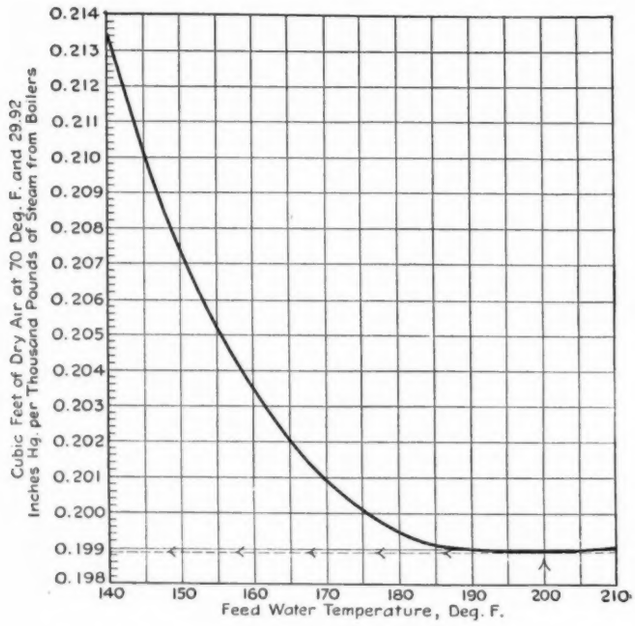


Fig. 1—Volume of dry air at 70 deg. F., 29.92 in. absolute dissolved in pure boiler-feed water

Based on Winkler's data and expressed in percentage by volumes.

The quantity of air entering with the steam from the boilers will be dependent upon the source of supply, type of feed-water heater and the temperature to which the boiler-feed water is heated, unless the feed water is deaërated before entering the boilers, in which case it should be practically zero. Fig. 1 has been prepared to show the relation of air dissolved in boiler-feed water to its temperature and may be used for estimating this portion of the total air.

The quantity of air liberated from solution in the condensing water depends upon five factors: (1) The source of supply; (2) the initial temperature of the water; (3) the final temperature of the water; (4) the absolute condenser pressure; (5) the quantity of condensing water. Of these five factors only the second and fifth need be considered, although a part of the air initially contained in the water will remain in solution, this amount depending upon the third and fourth factors. By assuming that all the air is liberated from solution, a small factor of safety is assured.

AIR LIBERATED PER POUND OF STEAM

Since it is customary to consider the quantity of condensing water in terms of pounds of water per pound of steam condensed, the curves in Fig. 2 have been drawn, using this ratio and the initial temperature of the water as a basis for estimating the quantity of air entering the system from this source. These curves have been based on Winkler's table of solubilities and represent an air content of 1.98 per cent by volume at 70 deg. F., as shown by Fig. 4.

If, however, the condensing-water supply has been tested and found to contain more or less than 1.98 per cent of air by volume of 70 deg. F., it will be necessary to multiply values from Fig. 2 by the actual percentage of dissolved air at 70 deg. and divide by 1.98.

In any condensing system the quantity of air leakage may be measured by the total volume of the system and the rate of increase in absolute pressure throughout the evacuated system with the vacuum pump shut down. The data in Table II have been drawn for the purpose

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TABLE I—SHOWING VACUUM-PUMP CAPACITY REQUIRED BY A BAROMETRIC CONDENSER

Item		Counter-Current Condenser			Parallel-Current Condenser			Source of Items
		Min.	Avg.	Max.	Min.	Avg.	Max.	
1	Temperature of inlet water, deg. F	60	70	80	60	70	80	Assumed
2	Temperature of outlet water, deg. F	90	90	90	90	90	90	Assumed
3	Heat in steam to condenser, B.t.u. per lb	1,241	1,241	1,241	1,241	1,241	1,241	Assumed
4	Pounds of steam condensed per hour	5,000	5,000	5,000	5,000	5,000	5,000	Assumed
5	Temperature at air-pump suction, deg. F	95	95	95	95	95	95	Assumed
6	Absolute condenser pressure, in. mercury	2.00	2.00	2.00	2.00	2.00	2.00	Assumed
7	Temperature of boiler-feed water, deg. F	200	200	200	200	200	200	Assumed
8	Volume condensing plant and piping, cu.ft.	8,000	8,000	8,000	8,000	8,000	8,000	Assumed
9	Allowed loss in vacuum per 24 hours, in. mercury	10	10	10	10	10	10	Assumed
10	Pounds of water to condense 1 lb. of steam	39.43	59.15	118.30	39.43	59.15	118.30	See ft. note
11	Dry free air from steam condensed, cu.ft. per hour	1.00	1.00	1.00	1.00	1.00	1.00	Fig. 1
12	Dry free air from water to condenser, cu.ft. per hour	69.00	94.00	173.00	69.00	94.00	173.00	Fig. 2
13	Dry free air from leakage, cu.ft. per hour	111.20	111.20	111.20	111.20	111.20	111.20	Table II
14	Total dry free air per hour, cu.ft	181.20	206.20	285.20	181.20	206.20	285.20	11+12+13
15	Cu.ft. dry free air per minute	3.020	3.437	4.753	3.020	3.437	4.753	14÷60
16	Pounds dry air to be removed per hour	13.57	15.45	20.35	13.57	15.45	20.35	14×0.07492
17	Pounds of dry air to be removed per minute	0.226	0.257	0.339	0.226	0.257	0.339	16÷60
18	Pounds of dry air per cu.ft. mixture	0.003525	0.003005	0.002335	0.001395	0.001395	0.001395	Fig. 3
19	Actual cubic feet per minute to be removed	64.11	85.53	145.20	162.00	181.22	243.01	17÷18
20	Volumetric efficiency of vacuum pump, per cent	55	55	55	55	55	55	Assumed
21	Pump displacement required, cu.ft. per min	116.6	155.5	264.0	294.5	334.9	441.8	19÷20

Note: Item (10) $\frac{\text{Item 3} - (\text{Item (2)} - 32)}{\text{Item (2)} - \text{Item (1)}}$

of estimating leakage from the change of absolute pressure over a period of 24 hours.

The quantity of air entering the system from the various sources already described has been expressed in cubic feet of dry air at 70 deg. F. and 29.92 in. mercury absolute, having a density of 0.07492 lb. per cu.ft. However, the "air" that must be removed from a barometric condenser is really a mixture of air and water vapor, saturated at the temperature of the water nearest the vacuum-pump suction connection.

TABLE II—LEAKAGE COEFFICIENTS FOR VACUUM SYSTEMS AT 70 DEG. F. 29.92 IN MERCURY ABSOLUTE.

For other temperatures, multiply by correction factor

Leakage, cu.ft. per hour = vol. coeff. × volume in thousands of cu.ft.
Leakage, pounds per hour = weight coefficient. × volume in thousands of cu.feet.

Increase in Absolute Pressure or Loss of Vacuum, Inches of Mercury	Volume Coefficient	Weight Coefficient	Temperature Correction Factors Temperature F.	Correction Factor
¼	0.3475	0.026	40	1.062
½	0.6950	0.052	45	1.050
¾	1.0425	0.078	50	1.038
1	1.39	0.104	55	1.029
2	2.78	0.208	60	1.019
3	4.17	0.313	65	1.009
4	5.56	0.417	70	1.0000
5	6.95	0.522	75	0.991
6	7.34	0.626	80	0.982
7	9.73	0.73	85	0.971
8	11.12	0.834	90	0.962
9	12.51	0.939	95	0.955
10	13.90	1.044	100	0.947
11	15.29	1.148	105	0.938
12	16.78	1.252	110	0.930
13	18.17	1.356	115	0.921
14	19.46	1.460	120	0.913

It is possibly heated above its saturation temperature by reason of structural peculiarities in the condenser head or the arrangement of the piping. Its temperature may be assumed to be the same as that of the outlet condensing water or slightly higher.

Proportion of Air in Vapor Removed

Since the volume of air or of the air-steam mixture actually present varies with the temperature, pressure and also with the proportion of dry air in the mixture, it is necessary to know what relation exists between the actual mixture to be removed from the condenser and dry air at 70 deg. F., 29.92 in. mercury absolute pressure.

In order to simplify the work of making such a comparison, the weight curves in Fig. 3, showing the pounds of dry air present per cubic foot of air-steam mixture, have been drawn for a total condenser pressure of 2 in. mercury absolute. Similar curves could be drawn for any other pressure that might be required.

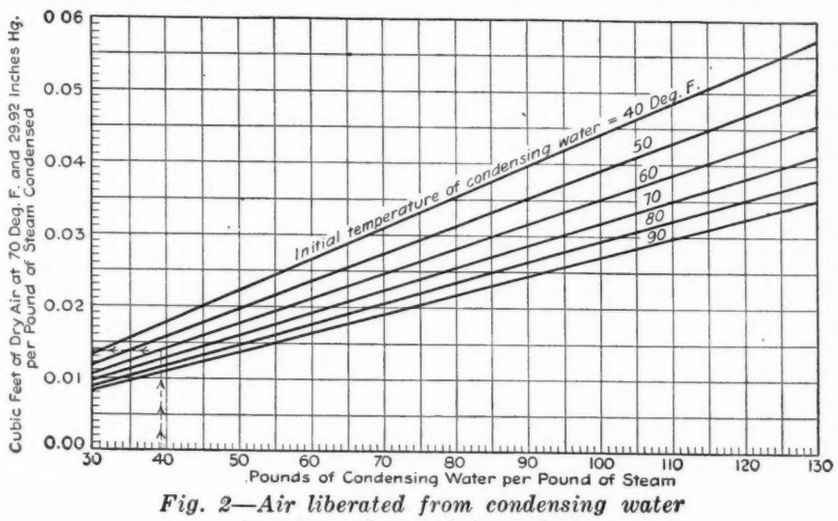


Fig. 2—Air liberated from condensing water in a jet or barometric condenser

Based on Winkler's data.

As a problem to illustrate the use of the various curves, consider the selection of a dry vacuum pump suitable for a barometric condensing installation having a total volume of 8,000 cu.ft. Condensing-water inlet temperatures are assumed to be 60, 70 and 80 deg. F. with an outlet-water temperature of 90 for all cases.

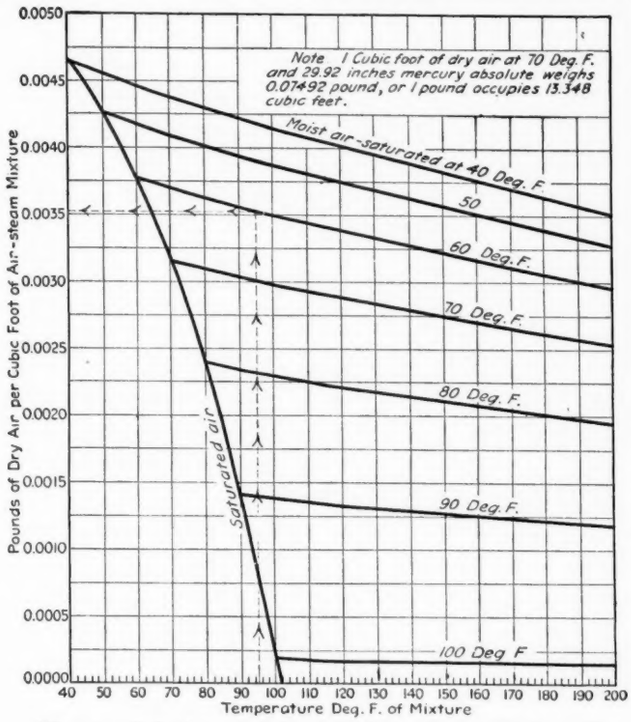

Note 1 Cubic foot of dry air at 70 Deg. F. and 29.92 inches mercury absolute weighs 0.07492 pound, or 1 pound occupies 13.348 cubic feet.
Pounds of Dry Air per Cubic Foot of Air-steam Mixture
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Moist air-saturated at 40 Deg. F.
50
60 Deg. F.
70 Deg. F.
80 Deg. F.
90 Deg. F.
100 Deg. F
Saturated air
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Temperature Deg. F. of Mixture

Fig. 3—Relative weights of dry air at 70 deg. F. in air-steam mixture

Based on Marks and Davis Steam Tables at a total pressure of 2 in. mercury absolute.

The absolute condenser pressure is to be 2 in. of mercury, and the quantity of steam to be condensed is 5,000 lb. per hour. Both counter-current and parallel-current condensers are under consideration. The vacuum-pump suction temperature is assumed to be 95 deg. F. The volumetric efficiency of a rotative dry vacuum pump is assumed to be 55 per cent.

The various calculations required are given in the Table I.

A study of this table brings out several points of interest, namely:

a. From items 11, 12 and 13, the quantity of air entering this plant by leakage is the largest portion of the total air to be removed except when excessive quantities of condensing water are required.

b. From item 14, the weight of dry air to be removed is independent of the type of condenser.

c. From item 19, the actual volume of air-steam mixture that must be removed from a parallel-current condenser is greater than that which must be removed from a counter-current condenser, all other factors being the same.

The formulas and constants used in preparing Fig. 3 are as follows:

$$pV = MR(t + 458.5) \quad (1)$$

in which p = absolute pressure in lb. per sq.ft.; V = volume in cu.ft. occupied by air or mixture; M = weight of V cu.ft. in pounds; R = "gas constant," ft.-lb. per deg. F., which is 53.35 for dry air and 85.89

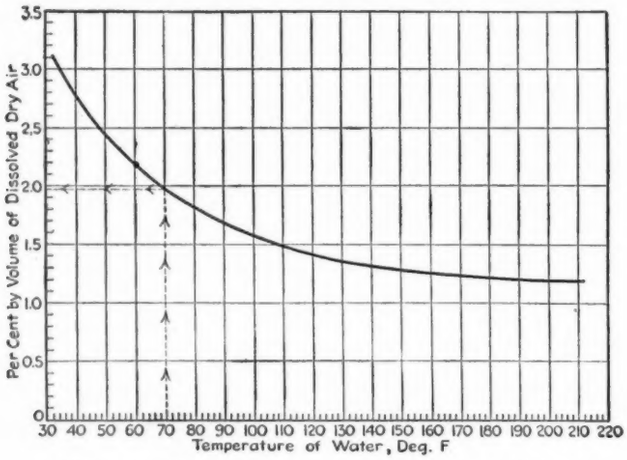


Fig. 4—Air carried in with steam, by volume

Based on Winkler's Data for various feed-water temperatures with open-type feed-water heater.

for water vapor; and t = temperature of air or mixture.

For a mixture of air and water vapor, the gas constant R is given by the expression

$$R_2 = \frac{R_1 + WR_2}{1 + W} \quad (2)$$

in which R_1 and R_2 are 53.35 and 85.89 respectively and W = lb. water vapor associated with one pound dry air.

The weight of water vapor associated with one pound of dry air when the air is saturated is given by the expression,

$$W = d \times 0.7556 \times \frac{(t + 458.5)}{(b - p)} \quad (3)$$

in which W = pounds of dry saturated water vapor per pound of dry air at t deg. F.; d = density of dry saturated steam in lb. per cu.ft. at t deg. F.; b = total pressure in inches mercury absolute of the air-steam mixture; p = pressure of saturated steam in inches mercury absolute corresponding to t deg. F.; and t = Fahrenheit temperature of air-steam mixture.

The weight of dry air in pounds per cubic foot of air-steam mixture is given by the expression.

$$A = \frac{(b - p)}{0.7556(t + 458.5)} \quad (4)$$

in which A = lb. dry air per cu.ft. of air-steam mixture and b, p and t are as in formula (3).

Detailed calculation for items in column 1 of Table I, are included as a further guide in applying this method.

Items 1 to 9 inclusive are assumed.

Item 10. Pounds of water to condense one pound of steam, is obtained from the expression

$$\text{Item 10} = \frac{\text{Item (3)} - [\text{Item (2)} - 32]}{\text{Item (2)} - \text{Item (1)}} = \frac{1241 - (90 - 32)}{90 - 60} = 39.43$$

Item 11. Dry free air from steam condensed, cu.ft. per hour is found by entering Fig. 1 at 200 deg. F. and reading 0.00019895 cu.ft. dry air per pound of steam. Then 0.00019895 × 5000 = 1.00.

Item 12. For dry free air from water to condenser, cu.ft. per hour, read Fig. 2 at 39.43 lb. water per lb. steam, going to 60 deg. curve and read 0.0138 cu.ft. dry air per lb. steam condensed. 0.0138 × 5000 = 69.

Item 13. Dry free air from leakage, cu.ft. per hour, is taken from Table II. Ten inches allowable loss (Item 9) gives a volume coefficient of 13.90 cu.ft. per hour per 1000 cu.ft. volume of system. Then 13.90 × (Item 8 ÷ 1000) = 13.90 × 8.000 = 111.20.

Item 14. Total dry free air per hour, cu.ft., equals Item 11 + Item 12 + Item 13 = 1.00 + 69.00 + 111.20 = 181.20.

Item 15. Cu.ft. dry free air per minute equals Item (14) ÷ 60 = 181.20 ÷ 60 = 3.020.

Item 16. Pounds of dry air to be removed per hour equals Item 14 × 0.07492 = 181.20 × 0.07492 = 13.57.

Item 17. Pounds of dry air to be removed per minute equals Item 16 ÷ 60 = 13.57 ÷ 60 = 0.226.

Item 18. Pounds of dry air per cu.ft. of air-steam mixture is found by entering Fig. 3 at 95 deg. air-pump suction temperature (Item 5). Project up to weight curve for moist air, saturated at 60 deg. F. (Item 1). For counter-current condenser, as in the fourth column from the left, read this at outlet temperature, (Item 2), 90 deg., and get 0.001395. Read 0.003525 lb. of dry air per cu.ft. of air-steam mixture.

Item 19. Actual cubic feet of air-steam mixture which is to be removed per minute equals Item 17 ÷ Item 18 = 0.226 ÷ 0.003525 = 64.11.

Item 20. Volumetric efficiency of vacuum pump, per cent, is assumed = 55.

Item 21. Pump displacement required, cu.ft. per minute, equals (Item 19 × 100) ÷ Item 20 = 6,411 = 55 = 116.6.

Summary

A method has been presented for estimating vacuum-pump capacity required by barometric condensers and measuring air leakage into condenser installations. Numerous curves have been presented for the purpose of making the necessary calculations graphically.

Curves dealing with the quantity of air carried by steam and water have been based upon Winkler's table of solubility of air in water, and those dealing with leakage have been based upon the rational method of noting loss of vacuum in a closed system. The leakage curves do not include reciprocating engines or turbines, as the leakage rate through glands and stuffing boxes is different when the unit is running from that when it is idle.

When making leakage tests on condensing engine or turbine installations it is therefore necessary to blank off the main unit at the exhaust flange and obtain the leakage in the condenser system alone. The air entering by leakage in the engine or turbine must be determined separately, either by special tests or by experience, and added to the amount of air that has been calculated by use of the various curves.

At Moose Jaw, Saskatchewan (Canada) on Dec. 6, 1923, trouble developed with the 3,500-kw. four-stage turbine. Upon examination of the turbine the third-stage wheel was found to be loose. Temporary repairs of the 3,500-kw. turbine were effected by removing the defective wheel with an acetylene torch and the unit was again put into commission, operating on three stages. Permanent repairs will be made when load conditions permit.—*The Electrical News* (Toronto, Canada.)

High-Head Penstock Failure Found Due to Bad Steel

Section of Thirty-Inch Pipe for 1909-Ft. Head Ruptures Through Laminated End of Plate—Welds Not Affected

ON DECEMBER 26 last, while the nearly completed high-head Eldorado power plant of the Western States Gas & Electric Co., near Placerville, Calif., was being made ready for trial operation, a section of the penstock burst while being filled. No material damage was done, and the operation of the plant was delayed only about three weeks, as by rush work the builder of the penstock succeeded, with the help of a fast cross-continent express shipment, in getting a new section in place in the line within two weeks from the date of advices to proceed. The circumstances and probable cause of the rupture of the penstock were studied by both the designer and builder of the plant, the Byllesby Corporation, of Chicago, and the builders of the penstock, the M. W. Kellogg Co., of Jersey City. The facts determined by these investigations are given by the makers, speaking for both parties, in the following account.

For the Eldorado plant, which is one of the highest-head water-power plants yet built in America, forge-welded pipe assembled with riveted bumped ring joints was chosen for the penstock construction. The static head at the bottom of the penstock is 1,909 ft. The penstock is a single line of welded pipe, ranging from 54-in. diameter at the top to 42-in. diameter about 300 ft. above the power station, where it divides by means of a special Y-piece into two 30-in. lines, each one supplying a single overhung impulse wheel of 14,000 hp. The shell thickness ranges from $\frac{3}{4}$ in. at the top of the line to $1\frac{7}{16}$ in. at the bottom. The section that ruptured is some distance above the bottom of the pipe, where the static head is normally 1,885 ft. This is at an expansion joint, and the section was made up by welding a short length of 32½-in. pipe to a length of 30-in. pipe, the enlarged upstream end receiving the end of the next length above in a sliding joint.

Pressure in Pipe Not Definitely Known

At the time of the break the line was being filled, and filling had progressed nearly to the top. The pressure that existed in the pipe at the time of the break is involved in some doubt; the known facts as to the water level in the pipe would make the static pressure 790 lb. per sq.in., though the gage at the power station showed only 760 lb. It is believed that the gage was not in condition to give an accurate indication at the time.

The pipe ruptured through its larger end, tearing apart longitudinally on a length of about six feet and ending in a short circumferential tear which allowed one side of the break to open out a foot or so under the pressure. The figure indicates the shape of the break and its relation to the welds of the pipe. It will be seen that the break was on the opposite side from the longitudinal weld and passed through the circumferential weld just as through normal metal of the pipe.

Examination of the fracture showed a normal weld without apparent defect, and normal, good metal except in the neighborhood of the sharp corner at the intersection of the longitudinal and circumferential tears. At the circumferential weld the metal was thinned slightly in forging.

At the corner of the two tears the plate is markedly laminated. There are a number of separate layers of steel visible, separated by dark streaks. It is believed that the fracture started at this point, directly downstream of the circumferential weld, the break then extending upward through the weld and through the 5-ft. length of the 32½-in. pipe to the upper end of the section. The stresses in the material under the conditions of the break were very moderate. With a pressure of 790 lb. per sq.in. the tension in the 32½-in. pipe was about 9,700 lb. per sq.in. and in the 30-in. pipe

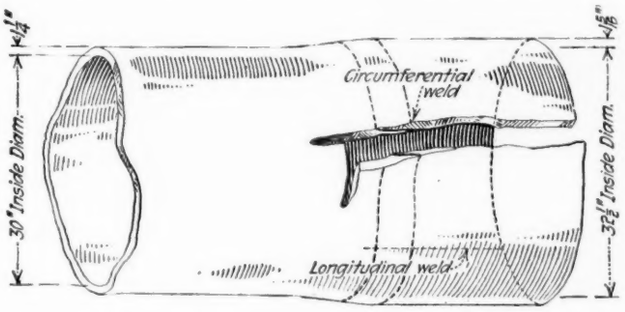


Diagram of ruptured penstock section

about 9,400 lb. per sq.in. At the point of the circumferential weld, where the metal was slightly thinned in forging, the stress would figure slightly below 11,000 lb. per square inch.

Laminations in the ends of thick steel plates have been found on one or two other occasions by the Kellogg company in its recent experience in making up thick-plate penstocks for high-head work. At the time the Eldorado penstock was manufactured, this difficulty had not been experienced, but it appeared in subsequent work. Such laminations occur at the end of the plate representing the top of the billet, and originate in pipes, slag pockets, or "fishtails" from rolling. Especially careful inspection has been instituted to detect and eliminate such laminations in heavy-plate work since their discovery. When they are suspected, the end of the plate is double sheared, the second cut being an inch or so back of the first cut; any lamination will be revealed by the sliding of one layer on another in the shearing. Examination of etched sections and microscopic study of structure are also used. Laminated sheets have been found to be weak under high bursting stress, because of a tendency to unequal distribution of stress between the different layers, the outer layers seemingly taking highest stress.

Specimens of steel from the ruptured section are to be analyzed and examined micrographically for any further information bearing on the failure.

In order to get the penstock into service as rapidly as possible, some very fast work was done in building, shipping and installing a replacement section. A new rolled-steel welding flange was ordered from Pittsburgh immediately on receiving word at Jersey City to proceed. Through the co-operation of another purchaser the flange was received at the Jersey City plant three days after ordering, and manufacture of the new section was begun on Jan. 2. The welding, forging, jointing and annealing, followed by testing to 50 per cent overpressure, were completed by the evening of Jan. 5.

Arrangements had been made to ship the section by express to Sacramento, and on completion the pipe was rushed to the waiting train at Jersey City and started that evening. There was a 20-hour train delay on the way, but the pipe reached Sacramento on Jan. 10 and from there was immediately trucked to the job, about 60 miles away. By Monday, the 14th, it was in the line and riveted up to the adjoining length, ready for service, and on the following day the plant started trial operation.

Eliminating Dust When Pulverizing Furnace Brick

About a year ago (in the Feb. 13, 1923, issue of *Power*) some mention was made of the application of the ring-type pulverizer to the grinding of old firebrick. The grog and fines resulting were mixed with high-temperature cement to form a furnace lining having higher heat-resisting power than the original refractory. Continued use of these machines for this purpose brought out the fact that considerable dust was raised during the operation, and where the location was in proximity to other machinery, it was found desirable to eliminate this dust.

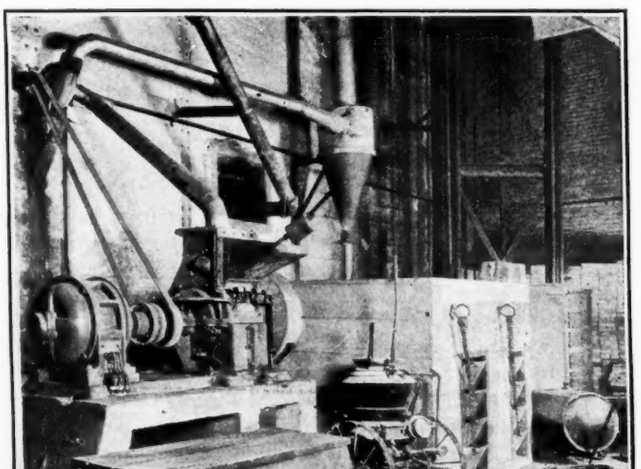
In an installation made at the Ashley Street plant of the Union Electric Light & Power Co., this was accomplished by belting a fan to the pulverizer shaft, as indicated in the accompanying photograph. A 4-in. fan in this case was supported on a wall bracket and suction connection made to the pulverizer case. In the line from the pulverizer to the fan, a bypass valve is provided to admit air into the line when it is desired to vary the suction, as it is this factor that determines the size of the material to be drawn from the pulverizer. In this way it has been found possible to obtain a 10- to 60-mesh product, the 60-mesh material and finer being used for dipping purposes and the 10-mesh and finer for common mortar used in bricklaying.

As shown in the photograph, the fan discharges into a cyclone which separates the air and the dust, the former escaping through the vent line to atmosphere and the dust dropping into the storage bin below.

The material discharged from the pulverizer through the grate bars in the usual way into the storage space underneath the machine, ranges from $\frac{1}{16}$ to $\frac{1}{4}$ in. in size, according to the spacing of the grate bars. Grading the size of the grog and the dust in the manner described makes it possible to mix the coarser material with a definite percentage of the fines, so that any degree of porosity can be obtained in the lining material.

For example, in a baffle wall in a boiler a large percentage of fines is used to give a dense material that will prevent leakage; whereas, the lining for a furnace wall should be as porous as possible to obviate blistering. For the latter purpose, therefore, mostly coarse grog is used, with just sufficient fines to provide a binder. To obtain even greater porosity, a certain mixture of coal dust ranging from 3 to 5 per cent is sometimes included. When the lining is heated up, this coal dust burns out and adds to the porosity of the lining.

For the outfit shown in the photograph, other uses have been found, such as the reworking of old asbestos pipe covering or asbestos insulating brick that were formerly thrown away. By the suction of the fan the asbestos fiber is drawn off the rings in the pulverizer before the fiber is damaged and delivered to the cyclone



Dust eliminating apparatus

and thence to storage, as before. On account of the length of the fiber retained, this material makes up into an excellent asbestos mortar for patching covering at pipe bends and similar work.

Another use for the machine is to convert waste concrete such as is broken off from old foundations when replacement is in order, into a useful product. To pass this material through the pulverizer, the grate bars are removed. There is sufficient space between the rolls and the breaker plates to allow $\frac{3}{4}$-in. material to pass through. This makes an excellent product to be used as the base for new concrete. Utilizing it saves the expense of carting it away and the cost of new material that would otherwise take its place.

In shutting down forced-draft fans: (1) Shut down the turbine or motor; (2) adjust the temperatures for operating with the fan unit shut down; (3) shut off the oiling system; (4) if the fan is turbine driven, close the exhaust valve; (5) and turn off the water cooling system.—*From the N.E.L.A. Operation Code Manual.*

Intelligent Operation Of Power Plants

THERE are plenty of examples to show that improvements have been made in power-plant operation to obtain higher efficiencies. There are also examples to show that in many plants, even of large capacity, there is much room for improvement in operation. This applies not only to steam plants, but also to hydraulic. For the intelligent operation the right kind of personnel and the proper type of equipment are essential—one is of little account without the other. The most intelligent and capable operating crew cannot produce results unless provided with the necessary equipment to obtain an intelligent record of operation. On the other hand, results cannot be obtained from the best-equipped plant unless the operators have the intelligence and training to get results. In fact, unless a trained personnel is going to have charge of operation, the simpler and more easily operated the plant can be made the more satisfactory the results that may be expected.

A steam plant designed for high efficiency must be operated by skilled engineers if economy is to be obtained. The more equipment there is to get out of order the more unsatisfactory will be the results, since there is more apparatus to give trouble. If any executive expects to build a high-class steam station and turn it over to an operating force that he hired because they would work for less salary than some others, he is wasting good money and a lot more of it than he probably ever will be aware of. This is equally true of employing high-class operators and putting them into an inefficient plant and then failing to support them in their recommendations for changes and equipment to obtain efficient operation.

When a large industrial establishment can, by employing the proper kind of operating talent in the power station and by the investment of only fifty thousand dollars for new equipment and making changes, save three hundred thousand dollars a year with the same production, it should be enough to shock any executive of a manufacturing plant into thinking about the possibilities of intelligent operation of his power plant, if he has not already found out that the right kind of engineers are the cheapest even if the salary account is not kept down to the irreducible minimum.

Although in hydro-electric plants there are not as many opportunities for inefficient operation as there are in a steam plant, there are examples to show that intelligent operation is productive of results. A case in mind is that of a large hydro-electric plant generating approximately one hundred million kilowatt-hours a year. By more intelligent operation the kilowatt-hour output for the same volume of water through the wheels was increased seven per cent. This additional power, at only one-half cent per kilowatt-hour, would give an increase in yearly revenue of thirty-five thousand dollars. This was in a plant where the operation was supposed to be above the average, and the result was obtained by placing a man in charge that had training and ability.

For many years there has been an increasing realization of the importance of the necessary equipment to give an intelligent record of plant operation. But in addition to this there is need of a more general appreciation of the importance of having properly trained men to use this equipment and the records obtained therefrom intelligently.

Superheat and Plant Efficiency

IT IS well known that an increase in superheat decreases the amount of steam required by a turbine, the usual allowance being eight per cent for every one hundred degrees Fahrenheit increase in superheat. An increase in superheat means an increase in the total heat of the steam, so that the actual reduction in fuel consumption is much less than the reduction in the total weight of steam at a given load. In fact, it may be said to be about three per cent for each one hundred degrees increase in superheat in the average turbine plant.

The thermal savings that are possible with high superheat are appreciated in the newer stations where total steam temperatures of 700 and 725 degrees will be used. These appear to be about the safe limiting temperatures for the materials that are now available for piping and turbines. Many of the older stations throughout the country have been equipped with superheaters to provide steam at much lower temperatures, in some cases 550 to 600 degrees. Should the economy of these older plants be improved by raising the steam temperature, and if so, how can it be done?

It will not be feasible in many plants to increase the superheat any great amount, for the steam piping, turbine casings, etc., have not been designed for high superheat. It is possible, however, in most of the plants of this class to realize the gain due to a moderate increase of superheat, and it may pay to make the necessary alterations.

Steam temperatures may be increased in two ways, either by additional superheating surface within the boiler or by separately fired superheaters. It is not always advisable to modify existing superheaters, and additional surface is sometimes difficult to install in the usual superheater location. However, the advent of the radiant-energy superheater has placed at the disposal of engineers an easy means of securing added steam temperatures at relatively little expense and with little disturbance to existing boiler plants. This may be used in place of troublesome bridge walls or side walls and may actually improve furnace-operating conditions and reduce brickwork maintenance.

The separately fired superheater can provide steam temperatures up to the highest practical amounts. Few of the older stations have piping, turbines or auxiliaries that have been built for seven hundred degrees or higher, and therefore this type of superheater must have a rather limited field of application. When a new turbine is to be added to an old station without increasing the number of boilers, the separately fired superheater might be considered, although it may not be justified after a careful study of operating costs. Its use abroad is more general than in this country.

Boiler-Room Bonus Systems

A FEW years ago much attention was being given to bonus systems designed to increase boiler-room efficiency. In spite of the apparent importance of the question it seems to receive less attention now than formerly, at least in this country. The reason for this condition is to be found in the fact that certain enthusiastic attempts to establish such systems ended in failure. As a result the whole subject fell under a shadow from which it is but slowly emerging.

One of the methods based a boiler-room bonus upon the percentage of CO_2 obtained, without regard to other conditions. This might have worked fairly well had not some of the firemen discovered that high CO_2 could easily be obtained while running their own boilers at very low output, leaving the other men to do all the work. Other systems were based on the water fed to the boiler per pound of coal. Here again the fireman with more ingenuity than honesty could beat the game by making excessive use of the blowoff valve.

In spite of these setbacks there is reason to believe that the general idea of a boiler-room bonus is sound. It is fundamental in any kind of productive work that the best results can be obtained only where reward is closely linked up with performance. This applies to all types of workers from ditch diggers to high executives. It is not human nature to exert one's best efforts if no personal gain is in sight.

The bonus question therefore deserves careful reconsideration on a common-sense basis to discover, if possible, some thoroughly practical system. The one apparently most in favor in Great Britain just now is simply based on the over-all station performance. For this purpose the total coal consumed per month is plotted against the total monthly output in kilowatt-hours. A straight line is drawn through the average position of these points. This serves as a reasonable standard for judging future performance, since it automatically allows for the effect of light and heavy loads. Whether or not bonus systems are installed on this basis, it would seem advisable for American plants to make more general use of this line, with which most British power-plant engineers are already familiar.

It is open to debate whether a blanket bonus to the whole staff, based on the over-all station performance, is the best, although it should normally result in some improvement in station economy. Its great advantage is its simplicity. Its obvious disadvantage is that it "causes the rain to fall upon the just and the unjust" and does not take proper account of each individual's share in the result. A more perfect system would be based on the performance of the boilers under the supervision of a single fireman. To do this successfully, the old pitfalls must be avoided by the use of a system where idling the boilers or wasting water through the blowoff valves does not increase the workman's bonus.

Another point must be carefully considered. In the development of bonus and piece-rate schemes in machine shops, many systems were completely wrecked by constant readjustment of the standards of payment as efficiency increased. As a result—and with some justification—the workmen ceased to "play ball." This situation is likely to arise in conection with boiler-room bonus plans if the management is not both far-sighted and high-minded. At the same time a permanently fixed basis of bonus would give the firemen credit for the economies due to more efficient apparatus. This point is perhaps the most difficult of all to handle, but further study of the subject may disclose some method that will be both effective and fair.

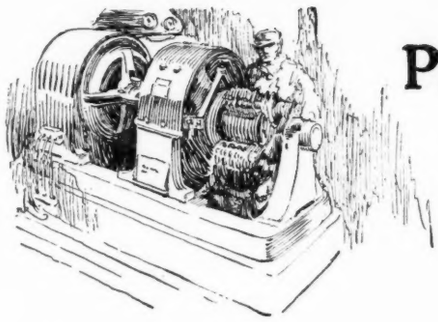
Saving Lubricating Oil

AN OBJECTION frequently raised against certain designs of semi-Diesel engines is that the cost of lubrication is excessive. In fact there are instances when, in an engine operating at a low load factor, the cost of the lubricating oil used per hour exceeds the cost of the fuel oil. Indeed, one reason for the low fuel consumption is the burning of large amounts of lubricant.

Part of this expense may be eliminated by so gaging the cylinder lubrication feed that just enough oil, and no more than necessary, is used. There is a too common habit of allowing the cooling-water jacket to scale badly and of depending upon excessive amounts of lubricating oil to keep the piston and cylinder cool. These disorders are due to faulty handling and can be corrected without trouble.

An additional cause of the excessive use of the lubricant is found in the location of the cylinder feed pipes. In many engines of both the horizontal and vertical types an oil line enters the cylinder at a point between the exhaust ports and the cylinder head. The scouring effect of the scavenging air wipes this oil off the cylinder walls, and it passes out the exhaust without performing its intended mission. There is no reason, beyond tradition, for an oil line at this point. If the feeds are at each side of the cylinder in a plane with the crankshaft and at the front just below or above the air ports, the oil will spread over the entire piston surface.

The most serious loss of lubricating oil and the easiest to correct is the drip into the crankcase. If this oil, which is more or less mixed with fuel oil dripping from the cylinder, is allowed to remain in the crankcase, the turbulence set up by the flow of air will break the oil up into a mist, which enters the cylinder along with the air. In most designs a trap is provided whereby this oil is drained out while the engine is in operation, but by reason of the black color and gritty nature, this oil is thrown away. An ordinary home-made cloth bag filter will do little beyond removing the larger carbon particles. The black color and the finer particles remain, and some approved type of filter is necessary. In many cases a further treatment consisting of heating, dosing with a coagulant, followed by agitation, is required to purify the oil thoroughly. The cost of oil-treating equipment is not excessive, and the resulting saving should pay for its first cost in but a few months. If all of the million horsepower of semi-Diesels in service were so equipped, the reduction in lubricating-oil consumption would be staggering.



Practical Ideas *from* Practical Men

What a Check-up on the Water Pumps Revealed

I recently took charge of a textile plant where the washing and dyeing processes absorbed a substantial amount of water. To all outward appearances this seemed correct. Several large storage tanks had been installed to provide sufficient supply to take care of the peak demands of these departments. The water bills were carefully checked each month by an office clerk. However, this work was not carried far enough.

Water was supplied by two pumps, one a 4-in., 300-gal.-per-min. motor-driven centrifugal, which ran continuously with a 6x7½x7-in. duplex steam pump. The latter had a maximum capacity of about 340 gal. per min., the two supposedly furnishing 640 gal. per min. The monthly reading of the city-water meter disclosed a quantity far short of this figure. The steam pump was then thoroughly overhauled, which resulted in slowing it down to less than one-half of its previous speed. It was then equipped with a pressure governor which further improved conditions so that it ran only just enough to keep up the required pressure. Still the water quantities did not check out correctly, so the centrifugal pump was dismantled. This proved to be so badly worn that it was discarded and a new duplicate unit installed. Upon putting the new pump in service, the duplex pump was shut down and has not been used since. The average demand had been figured to be 285 gal. per min., sufficient to supply the needs of the plant, the storage tanks taking care of the peak loads.

Inquiry revealed that these two pumps had been running together for about three years. While the steam economy is small, the wear on one pump is eliminated and a spare pump is always ready to be used in case of emergency.

H. M. TOOMBS.

Chicago, Ill.

The Salesman as an Educational Factor

It needs no argument to support the fact that the power-plant operator needs and must have up-to-date knowledge and information relative to his business and equipment in order to operate his plant at highest efficiency. The old strong-arm methods are largely past, and the more headwork used in the design and operation of any plant, however large or small, the better the results.

To this end your engineer subscribes to and reads engineering periodicals; to this end he buys books on the subject; for this reason he burns the midnight oil over his correspondence-school instruction papers. He visits other plants, talks to other engineers and writes letters of inquiry—all in order to keep himself posted and up-to-date on his work, so that the superintendent or general manager will be satisfied that he has a good man in charge of his power-house machinery.

While heartily approving the efforts their engineer makes on his own behalf for self-improvement, a large number of firms overlook a big source of information with which they could provide him—the up-to-the-minute information to be obtained free of cost from the traveling salesman. Why is the salesman prohibited from seeing the engineer and having a sociable chat about the line the salesman carries? Are they afraid their man will want to order something he could do without? Are they burdened with the thought that the salesman's proffered cigar may be the means of their having a new pump or stoker to pay for? Or do they begrudge the time apparently lost by their mechanic from his usual chase after leaks and the like?

The salesman as a rule is a specialist on a certain subject. He has been put through a generous course of training in order that he may be thoroughly familiar with every detail of the goods he sells. Let us assume that he travels for a firm manufacturing pumps. He must then know not only his own pumps, but those of his competitors. He has seen the interior of lots of other plants, and he has had the benefit of his firm's experience with similar installations. He is in receipt of daily or weekly bulletins from the head office giving him the latest word on his line.

This man is competent to give your engineer good advice about the selection of just the right pump. It would be of no advantage to him or his firm to sell you one that he knows would not be satisfactory, and in case of doubt he will refer the question to his firm's engineers. Competitors are glad to give the same service through their salesman. The selection of a certain piece of machinery after all the salesmen have exhausted their fund of knowledge on the subject, is an education in itself.

If, on the other hand, you decide to employ a firm of mill engineers to select this pump or other piece of machinery, the first thing the expert does is to call in the salesmen of this piece of machinery, describe the conditions and ask them what they have that will most nearly fit. They know the value of the salesman and you pay them a commission for their so doing.

If you are afraid of your engineer "grafting" on you, so that you dare not let him see a traveling man, you had better change engineers. If he is that kind of a chap, you do not want him. He is probably taking coal home at night in the rear of his automobile, greased with your oil. Personally, I consider the firms that allow their salesman to offer a graft are few and far between. I've heard of them, but in twenty-five years never met but one.

Maybe you count the time spent while a salesman is calling on your engineer as so much lost. If that

is the case, your man probably is too busy trying to hold a lot of junk together to see much of anyone—and he is probably also busy thinking about some other job.

Salesmen are human beings just like the rest of us. When they see a fellow working perhaps in rather difficult circumstances, they may know of some kink or method they have seen somewhere else that would help this case. If not, they look around or ask until they find out the remedy. Some of the best kinks I ever got hold of came from the traveling men who were observant in their calls in other plants.

And so, without discounting any of the other sources of information about the business, when you want to know something definite, up-to-date and accurate, try out our friend the traveling salesman. C. A. HARRIS.

Winston-Salem, N. C.

Method of Relining and Oiling Hubs of Loose Pulleys

In the plant where I was formerly employed, there were many loose pulleys in which the hubs were lined with babbitt metal. In renewing these linings we used the following method:

A wooden mandrel was turned to a diameter to give a running clearance on the shaft and tapered to a larger diameter at one end, as shown in Fig. 1. When it was necessary to rebabbitt a pulley, the old babbitt was first melted out on the forge, then the hub was slipped over the mandrel until it rested on the shoulder, which was supposed to center it. After leveling the pulley by using blocks and wedges under the rim and plugging up the oil holes, the babbitt was poured in the usual way and allowed to cool. A sledge was then used to drive out the mandrel, and after cleaning the oil holes, the pulley was put back on the shaft.

When a loose pulley is designed according to Fig. 2,

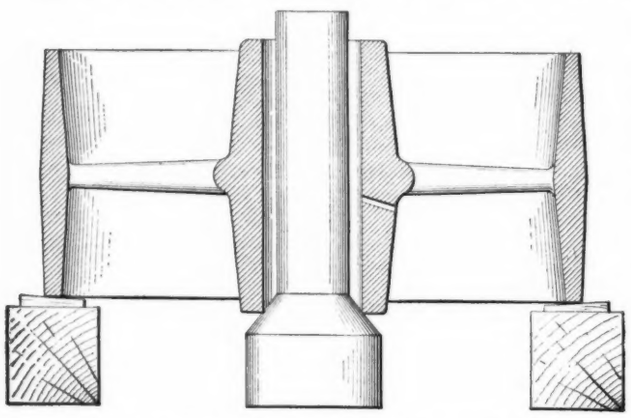


Fig. 1—Pulley is slipped over mandrel and centered by taper

it is sometimes difficult to secure satisfactory service from it. The hub is shorter than the face of the pulley, when it ought to be 20 per cent longer. A short hub gives insufficient bearing surface, and this results in excessive wear, especially where the oiling is not given careful attention.

One special pulley in our shop was fitted with an oil tube, as illustrated in Fig. 3. A screw was fitted into this tube so that when the bearing was to be oiled, this screw must be removed. The tube was probed with a copper wire, and if found clear, it was filled with oil, then the screw was replaced and screwed down tight. This prevented the oil from being thrown out by centrifugal force. The hub of the pulley was lined originally with babbitt metal, but this was replaced later with a brass bushing. The bushing was made a loose running fit on the shaft and also in the hub, so that it could revolve with the pulley or stand still with the shaft, according to what surface presented

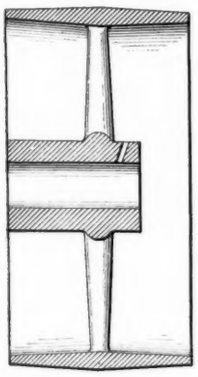


Fig. 2—Short hub gives insufficient bearing surface

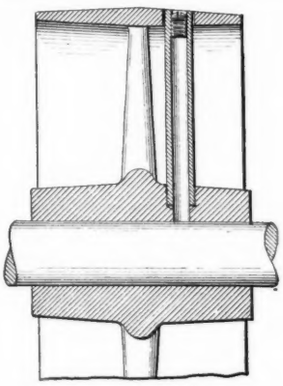


Fig. 3—Pulley fitted with oiling tube through rim

the least friction. It was also fitted with two oiling tubes similar to the one shown in Fig. 3.

Another loose pulley, which formed part of a friction clutch, was fitted with a brass bushing containing three slots about ¼-in. wide, in which were placed strips of felt. I removed the felt from one of them, as I considered it was safer to have one place where the oil could flow down to the shaft, without possible obstruction.

As it is not practical to run the belt off a loose pulley every time it is oiled and it frequently stops in such a position that the oil hole is not accessible, three oil tubes, as shown in Fig. 3, spaced 120 deg. apart, were fitted in some pulleys. Whatever position such a pulley may stop in, one of the oil tubes is always accessible. All these tubes are fitted with screws to close the holes, and care must be taken when replacing them, to screw them down until they are tight; otherwise they are liable to work backward in service until they project above the face of the pulley and damage the belt.

Frequently, a friction clutch pulley is 4 or 5 ft. in diameter, in order to secure necessary speed of a machine. Such a pulley needs special care, because when standing still the wear (due to the revolving shaft) all comes in one place on the bushing; hence, it requires but a little lost motion to make the pulley noisy. Where the pulley continues to revolve after the shaft is released the wear on the bushing is distributed over the entire surface.

I have one drive where the belt stands vertical, with the driving pulley on the lower shaft, and I find that the clutch pulley needs oiling once in about three months. When the clutch is thrown in, no oil is required, and when it is out, the vertical belt supports the pulley, so that there is very little friction on the shaft.

If a loose pulley is allowed to travel back and forth on its shaft for about ⅛ in., the oil will have a much better chance to lubricate the surfaces than it does where the collar is set so close that the pulley must always travel in exactly the same place.

New Haven, Conn. W. H. WAKEMAN.

Comments from Readers

Eye Protector for the Fireman

Having experimented with various kinds of eye and face protectors for firemen, I should like to make a few comments on the articles that appeared in the issues of Jan. 15 and 29 entitled "Eye Protector for the Fireman."

We have found, as Mr. Kirkpatrick has stated, that celluloid shades will burn up when brought close to a furnace, thereby imperiling a man's eyes. Goggles are good for eye protection, but do not keep the heat from the face. Then they are usually removed from the face when not in use and are liable to be dropped and broken. The shade made of fine copper wire cloth, as explained by Mr. Kirkpatrick, may be all right in some cases, but it does not give clear vision or good heat protection in general, as copper is a good heat conductor and is not cooled readily.

Upon the completion of our tests and experiments we decided to manufacture a cap of light-weight cloth having a large peak containing two glasses of cobalt blue, focused so that a slight bend of the man's face forward enables him to see the whole fire and still protect the eyes and face. The peak is made of heavy cardboard covered with the cap cloth. The glasses are held in place by a small metal rim.

These caps have been in use by our firemen for about three years with much satisfaction. We employ upward of fifty fireroom attendants, and our fires range in temperature from 2,000 to 3,000 degrees.

J. CHESTER APPIARIUS, Safety Engineer,
Brooklyn, N. Y. American Sugar Refining Co.

Forces Produced by Pipe Expansion

On page 148 of the Jan. 22 issue is an article on the "Forces Produced by Pipe Expansion." In this article there is the assumption which seems to be general practice in figuring the expansion of metals when used as envelopes for high-temperature substances. This is the assumption that the pipe, boiler, or whatever form of envelope, may be considered as of the same temperature as the substances that may be on the inside. In this particular article mention is made of admitting steam at 150 lb., 100 deg. superheat (total temperature 466 deg.). It is figured that the pipe will expand an amount equal to the coefficient of expansion times the number of degrees increase in temperature of the steam over the initial cold temperature. The question in my mind is whether it is correct to assume that the metal attains the same temperature as the substance inside.

This question has arisen in my practice where we frequently have to design steel-plate flues for hot smelter gases and make proper allowance for expansion. Apparently, the real temperature of the steel plate is somewhere between the temperature of the gases inside and the external atmosphere. It is not exactly the mean of these two temperatures, but for all practical purposes can be assumed as such. Would this not be a more correct way of figuring the expansion of steam pipes? I have no real data on what actually occurs in steam pipes, so would greatly appreciate being enlightened.

Of course, where steam pipes are covered with an efficient insulating medium, it is conceivable that the metal will attain approximately the temperature of the steam on the inside. Even then, however, it does not seem reasonable to assume that the metal actually attains the full temperature of the steam.

Further information on this subject will be appreciated by me and will undoubtedly be of interest to other readers. L. D. ANDERSON.

Salt Lake City, Utah.

Too Old at Forty?

I read with interest the editorial in the Jan. 8 issue, entitled "Too Old at Forty?" and am strongly in accord with the views there expressed as they are timely and to the point. It is true, undoubtedly, that "judgment, reliability, common sense, knowledge, practical experience, executive ability—are the big factors in an engineer's value"; for these are necessary to securing efficiency in power and manufacturing plants.

What is needed in industrial organizations is the kind of enthusiasm from employers that will lead men to follow the path of industrial progress. Sentiment is also essential in order to obtain and maintain productive efficiency. Personally, I believe in scientific management, but not in espionage that makes men feel they are mere automatons, driven by their employers. Unfortunately, some employers seem to prefer young engineers as production men, with slide-rule and stop-watch qualifications only, but fortunately, some of our more progressive plants know that nature takes years to make a man and man takes years to build up a character.

For many years it was the rule of the railroad company where I am employed, not to take on employees who had reached the age of forty for its power and manufacturing plants, although some engineers were accepted who had well passed the fortieth milestone, through an incorrect age being given. During the last twelve months the "too old at forty" rule has been rescinded. At present new employees up to fifty-five can be taken on when vacancies occur, provided they pass the medical examination test by the company's doctor.

The workmen's compensation law, which aims at the conservation of human life in industry, in pre-war days caused a wholesale weeding out from employment of elderly engineers in power and manufacturing plants. It would appear that employers have been too prone in the past to look upon elderly engineers as being inefficient in production.

Experience as a foreman for the last twenty years in various engineering plants shows that it is exceptional to find a young man who is thoroughly competent to execute any branch of his trade on completing his course of apprenticeship. Of course I refer to the

highly skilled engineering trades, which demand manipulative skill, intelligence and judgment. In our plant I thoroughly appreciate the services of the elderly men, many of whom have made a study of shop methods and the need for greater efficiency in production. Another reason is, if the foreman is absent from the shop, the engineer of mature years can be relied on, whereas, the young engineer, whenever he has the opportunity, generally slackens his speed of work. So-called "sport" monopolizes much of his ability to the detriment of production.

It would appear to be more desirable if men were selected like raw material by experts trained for the job—in other words, scientific selection of employees. Men should be fitted with jobs just as they are with clothes. The proper place for the proper man would then result regardless of age.

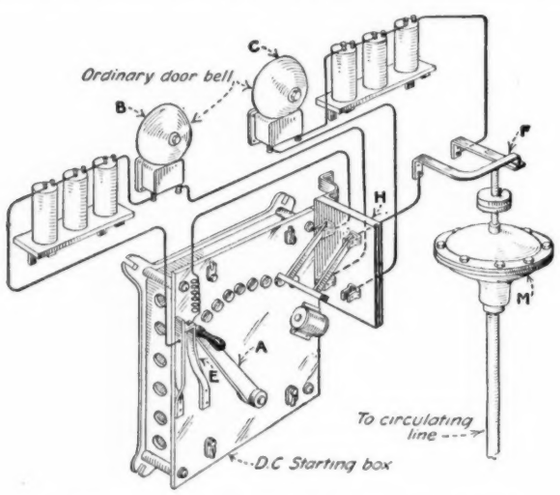
Why should an engineer cease to be in demand merely because he has passed forty? This is a problem that has always been a puzzle to me. Personally, I prefer to employ men that have passed the fortieth milestone.

Manchester, England. E. ANDREWS.

Double-Circuit Alarm for Circulating-Water Systems

The alarm circuit shown in the illustration is an improvement, I think, over the device described by Mr. Thomas in his letter in the Jan. 22 issue, entitled "Stopping of Circulating Pump Causes Crack in Condenser Shell."

Some years ago I had some experience with a similar alarm and found that the wire in the water and mercury became dirty and caused resistance enough to prevent the flow of current, thereby making the alarm inoperative. Also, since an electric bell is not infallible, it should be installed so it can be tested conveniently.



Arrangement of alarm contacts and circuits

In the double-alarm arrangement shown in the illustration, two independent circuits are used. If the power circuit opens, the starting box lever *A* will close the contact *E*, causing the bell *B* to ring, and when the pressure drops the contact *F* will close and the bell *C* will ring.

The two-pole switch *H* is placed in such a position that it can be opened to stop the bells from ringing, but cannot be left open by mistake, as the switch is placed so that the end of the lever *A* pushes the switch closed before the end of travel.

The bells can be tested as often as desired by pressing the contact spring in each circuit. The bell circuits are connected to the double-pole switch, so that opening or closing the switch controls both circuits.

An ordinary diaphragm regulator is connected to the pressure line and can be weighted to close the alarm circuit at the desired pressure. In my opinion this alarm will give much more reliable service than the one used by Mr. Thomas. The contacts are located where they can be easily kept in good condition, and the bells are readily tested at frequent intervals.

Brooklyn, N. Y. C. A. ENGGREN.

Coal for Banking

In an article entitled "Continuous Power-Plant Testing," by Theodore Maynz, in *Power*, Feb. 5, 1924, there appears an equation for computing the coal burned during banking hours, as follows:

$$\text{Lb. of coal} = a + bx$$

where

a = Pounds of coal wasted in coming into and off a bank;

b = Pounds of coal used per hour while banked;

x = Number of hours of duration of bank.

Values of the constants a and b are then given for chain-grate and underfeed stokers.

Information applying to chain grates is not in my possession, but the values for underfeed stokers do not agree with results obtained in a recent test. A paper on this test, entitled "Tests of a Stirling *W* Type Boiler at the Connors Creek Power House of the Detroit Edison Co.," was presented at a meeting of the American Society of Mechanical Engineers and published in the transactions of that society for December, 1922. Careful measurements of coal were made on this test with banks of various duration, and from these data an equation was worked out for this boiler (which has an effective projected grate area of 284 sq.ft.), as follows:

For floating bank, lb. of coal $= 8{,}600 + 105x$ and

For dead bank, lb. of coal $= 8{,}000 + 280x$, x being the number of hours of duration of bank as before.

Putting the constants in these equations on a basis of square feet of grate area for comparison: $a = 30$ lb. per sq.ft. of grate for floating and 28 lb. per sq.ft. for dead bank; $b = 0.37$ lb. for a floating and 0.99 lb. for dead bank.

Although it is not stated, the figures given by Mr. Maynz are probably for a dead bank. For a ten-hour dead bank the coal consumed based on the equation from the Connors Creek test is, for this boiler of 284 sq.ft. of grate, 10,800 lb., whereas Mr. Maynz' equation for the same boiler would give a maximum of 3,500 lb. or about a third as much.

The equation and constants given in the article are no doubt correct for a certain type and size of boiler with underfeed stoker, but it seems to me that the comparison made shows that a simple equation for coal burned on banks cannot be applied to any type or size of boiler using underfeed stokers. There are so many variables entering into this calculation that an equation applicable to all boilers of one class is practically impossible. There are variables outside of the boiler

itself such as the method of banking and the kind of fuel. The data on the Connors Creek test were evidently not put into the form of an equation in order to apply to other boilers, but merely for computing coal burned on banks of various duration for that particular type and size of boiler.

It would hardly seem advisable to use this form of equation in connection with all underfeed-stokered boilers, since it is, presumably, based on a test of one certain boiler.

GEORGE A. CHATEL.

Cleveland, Ohio.

Application of Various Types of Coal-Handling Equipment

In an article in the Jan. 29 issue entitled "Application of Various Types of Coal-Handling Equipment" George E. Titcomb says that a $45,000 locomotive crane will handle coal to storage at 6.46 cents a ton, while with a $15,000 cable drag scraper system, the cost per ton will be 8.8 cents.

Mr. Titcomb's figures may be assumed as being correct for the locomotive crane, as he is familiar with this class of equipment, but from the figures he gives for the cost of operating a cable drag scraper, it is apparent he is not at all familiar with this device, and since the writer is, he offers the following corrections:

COST OF OPERATION (8-HOUR DAY)

1 operator	$5.00
Burden (150 per cent of labor)	7.50
Current, 240 kw.-hr.@3 cents	7.20
Oil, etc.	.50
Repairs and replacements	1.00
Interest on investment	3.00
Taxes and insurance	1.50
Depreciation and obsolescence	3.00
	$28.70

Mr. Titcomb gives $66 as the cost of operating a drag scraper eight hours, during which period 750 tons of coal are handled. Dividing the dollars by the tons, he arrives at 8.8 cents per ton, whereas this cost should be $28.70, divided by 750 tons, or 3.82 cents per ton.

He compares a 5½-yd. locomotive crane handling 1,500 tons per day with a 1-yd. drag scraper handling 750 tons per day. If he had taken a 5½-yd. drag scraper, the 8-hour rate at 100 ft. haul would have been 3,200 tons per day, with no increase in labor or burden charges, which are the largest items in the cost.

The drag scraper system tabulated, at a price of $15,000 includes the price of a skip hoist for unloading the railroad cars and elevating the coal to a pile alongside of the railroad track, from which the drag scraper stocks it out. In the case of the standard-gage revolving locomotive crane, data for which are given on page 189, the cost per ton given by Mr. Titcomb is 11.64 cents, based on handling 600 tons per day. If the $15,000 skip hoist and drag scraper handle 600 tons per day instead of 750 tons, there is a cost per ton of 4.8, but it must be remembered that the small-radius standard-gage locomotive crane cannot store much coal without having an auxiliary means for distributing the coal over the storage area. When it is used for stocking out from trestles, it can store considerable coal, but on the other hand it must be remembered that the drag scraper system can also stock out from a trestle, in which case it costs $5,000 instead of $15,000 since the unloading means are eliminated.

In this case, following through the same method of figuring, the cost of stocking out 750 tons of coal from a trestle, over a period of 8 hours, with a drag scraper, would be at the rate of 2.83 cents per ton.

H. E. BIRCH, Engineering Manager,
Philadelphia, Pa. R. H. Beaumont Company.

[In his original paper Mr. Titcomb stated that no generally applicable cost figures could be laid down for a given apparatus. The cases cited were merely given as typical examples. The following is an extract from Table IV to which reference is made in the preceding letter:

COST OF OPERATION (8-HOUR DAY)

Average haul, ft.	100
Capacity in 8 hours, tons	750
1 operator	$8.00
2 helpers for dumping cars	10.00
Burden (150 per cent of labor)	27.00
Current, at 1 cent per ton	7.50
Oil, etc.	2.00
Repairs and replacements	4.00
Interest on investment, 6 per cent on $15,000	3.00
Taxes and insurance	1.50
Depreciation and obsolescence	3.00
	$66.00

—Editor.]

Stuck Pistons

The article "Stuck Piston in Oil Engines," in *Power*, Feb. 5, clearly explains the growth in pistons. It may, however, be of further interest to know the method adopted abroad, which eliminates all possibility of piston seizure either by "growing" or faulty circulating-water control.

On the engine being started for the first time, it is run light, which allows the lubricating oil to penetrate the working surfaces. A prony-brake test is now applied and the load increased until the desired output is obtained. Should the pistons of any of the lines show signs of seizure, which is easily detected by the knocking of the piston in the liner, the fuel is instantly cut off, bringing the engine to a quick stop. The offending piston is then withdrawn and easied off at the hard places, which are generally found along the skirt of the piston. The heat radiating from the top through the adjacent internal strengthening ribs and piston pin bosses distorts the skirt, and the growth of this portion is greater than at the piston head. If the piston is binding on both sides—that is, in a line with the axis of the crankshaft—it must be eased off either by filing or by grinding; should it show signs of binding across corners, the alignment of the connecting rod or cylinder is apparently out and must be corrected.

On replacing the piston, the engine is again put under load. Should it pass through this operation without showing any further signs of piston knock, the inlet water to the cylinders is closed off, allowing only enough water to be discharged to insure that the jackets are completely full. The load on the engine is further increased until the water in the jackets boils, and the pistons must go through this test without knocking. The conditions are now that both the pistons and the cylinders are expanded. The inlet water is turned full on, shrinking the liner on the hot piston. If the pistons are of the right diameter and the cylinders and connecting rods in alignment, the engine will pass through this process without any undue labor, showing that the piston friction is reduced to a minimum. This is the test required before any indicator diagrams are taken off and covers the mechanical efficiency, enabling this to be obtained under all operating conditions on the field.

H. T. MELLING.

New York City.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Loss of Heat in Chimney Gases

How much of the heat of coal used for firing boilers is lost in the chimney gases? R. L. D.

The percentage of heat lost in chimney gases depends on the analysis, quantity and temperature of the gases. In ordinary practice with natural draft, it is common to supply boiler furnaces with more than 100 per cent excess air in order to insure complete combustion, and the losses with different temperatures of chimney gases are about 17.5 per cent for 400 deg. F., 21 per cent for 500 deg. F., 29 per cent for 700 deg. F., and 33 per cent for 800 deg. F.

Treating Overheated Low-Pressure Crankpin

What should be done in case the crankpin becomes heated on the low-pressure side of a cross-compound engine? W. W.

First of all, relieve the low-pressure side of the engine of part of its load by increasing the length of cutoff in the low-pressure cylinder. Then slacken off the brasses and keep the pin flooded with thin oil. At the first opportunity remove the brasses and thoroughly clean all surfaces of the pin and brasses and oil passages. Wipe off the pin and bearings with clean cylinder oil mixed with a little graphite and, in restarting, have the brasses slacker than usual, keeping the pin flooded with thin oil. Key up the brasses a little at each stop of the engine, and if the pin remains cool, gradually restore the proportion of load by shortening the low-pressure cutoff.

Overloaded Motor

Can the armature of a 4-pole 25-hp. 250-volt compound interpole motor be wound wrong and operate satisfactorily except that it takes 175 amperes and overheats? This motor is belt connected to a fan with a 15-in. pulley on the motor and a 24-in. pulley on the fan. The motor operates satisfactorily in every way with the exception of heating, there being no sparking at the brushes. When the motor pulley was changed to one of 8-in. diameter, the load on the motor decreased to 50 amperes. H. M. W.

The only trouble with your motor driving the fan is that with the 15-in. pulley on the motor it drives the fan at a speed that causes the motor to be overloaded. The load on a fan varies rapidly with a change in speed. With some designs the load varies as the cube of the speed; that is, with double the speed the power becomes eight times as much. In your case apparently the power varies approximately as the square of the speed. When you changed from a 15-in. pulley to an 8-in. pulley, you reduced the speed of the fan approximately one-half, and the power to approximately one-quarter what it was with the 15-in. pulley. If you will use an 11-in. pulley on the motor, it will be found that a machine will take about normal full-load current of about 90 amperes. If you wish to drive the fan faster than this, it will be necessary to use a larger motor. There is nothing wrong with the motor connections, and it must be a good motor to stand 100 per cent overload without sparking at the brushes.

Gasket for Leaky Ground Joint of Cylinder Head

What is a good material for a gasket to go on the ground joint of a steam cylinder head that shows leakage? W. B. G.

A good gasket can be made of detail drawing paper. Before applying a gasket, have the ground joint surfaces perfectly clean and coat them with powdered graphite rubbed on with the finger. For very high pressure or for superheated steam before applying the gasket give the surfaces a thin coat of shellac varnish in which powdered graphite has been thoroughly mixed, and place the gasket while the shellac is tacky. Set up the nuts all around only a little at a time, beginning each time at the place where the joint leaked, working away from that point, first on one side and then on the other. Whenever it is desired to stop leakage at a point, do not attempt to set up the nuts of studs on each side of the leak without first slightly slacking off all others.

Cutting Snap Ring

If a snap ring for a piston is received uncut, how may it be known how much of the ring should be cut out for use in a given cylinder? T. H. R.

The amount cut out of the ring must be such that the outside circumferential length that remains will be equal to the circumference of the cylinder bore, plus the circumferential distance which the cut ends are to overlap. The length of circumference of the cylinder bore can be found and laid off on the ring by springing a wire or narrow strip of steel inside of the cylinder, marking the wire where it laps and transferring the the length of cylinder circumference to the outside circumference of the ring. The best method of determining the amount to cut out is to make a single hacksaw cut across the ring at the desired angle for the ends of the laps. Then, with the cylinder head removed, set the piston a few inches from the head end of its stroke and place the ring in the cylinder bore with the cut ends sprung one over the side of the other. So the mean position will be square across the cylinder, have one cut end against the piston and the side that is diametrically opposite the cut ends one-half the width of the ring

away from the piston. With the ring thus placed, block it out from the inside so it will be in contact with the cylinder bore all around. The lap and joints then can be laid out for doing the cutting with the ring removed from the cylinder. But before the ring is finally mounted on the piston, it should be placed in the cylinder square across the bore, to test whether the cutting is of proper amount when the ring is blocked out all around to the bore of the cylinder.

Deposit from Cylinder Oil When Using Superheated Steam

We are using steam at 150 lb. pressure with 100-deg. superheating for large hoisting engines, and the cylinder oil is supposed to be of good quality for the conditions. However, upon opening a cylinder we find a black oily deposit on the cylinder walls and piston. The deposit does not exactly resemble oil; it has the appearance of a dirty oil. Is this condition to be expected with the use of superheated steam or is the oil unsuitable? *A. M.*

Most oils used with superheated steam are likely to show some degree of breaking, but with good oil the trouble should not be so great as described. Probably it is due to using a mixture of oils of high and low viscosity for the purpose of obtaining more desirable viscosity. If the refiners are informed of the conditions of use and objectionable experience with the present oil, undoubtedly they could take steps to supply a cylinder oil giving satisfactory results.

Receiver Pressure Below Pressure of Atmosphere

In a triple-expansion engine, operated condensing, how is work obtained out of the low-pressure cylinder if the pressure in the receiver between the intermediate and low-pressure cylinders is below the pressure of the atmosphere? *J. N.*

Work is performed in an engine cylinder when the average absolute pressure, or pressure above a perfect vacuum, which acts to move the piston during the admission stroke, is greater than the average absolute pressure that opposes the return of the piston during the exhaust stroke. Hence, although the pressure of steam admitted from the receiver may be less than the pressure of the atmosphere, which is 14.7 lb. per sq.in., if the average absolute pressure acting on the piston during the admission stroke is higher than the average absolute pressure during the exhaust stroke, due to operation of a condenser, just as much work will be performed as if the same difference of average pressures were obtained from pressures above the pressure of the atmosphere.

Approximate Tests of Engine Alignment

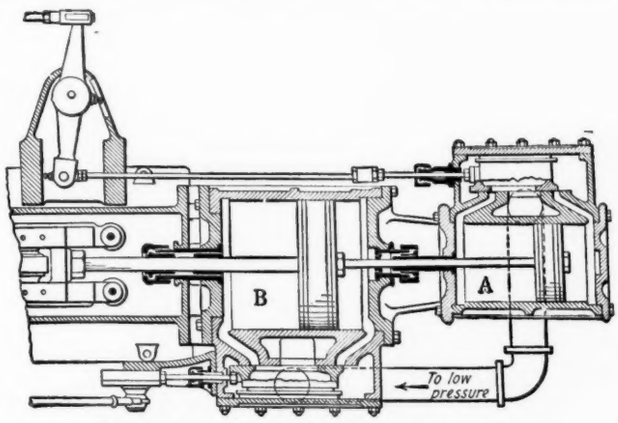
Without stripping an engine how may it be known that it is out of line? *M. F.*

If the guides are parallel with the cylinder center line, the crosshead is too high if the piston rod is nearer the cylinder end of the lower guide when the crosshead is at the crank end of its stroke than when near the cylinder end of its stroke; or the crosshead is too low if the piston rod is farther from the cylinder end of the lower guide when the crosshead is at the crank end of its stroke than when near the cylinder end of its stroke. If the same distance cannot be obtained by adjusting the height of the crosshead, the guides are not parallel vertically with the cylinder center line. In the same manner lateral adjustment of the crosshead can be tested. To determine approximately whether the shaft is square with the path of the crosshead, place the engine first on one center and then on the other, each time measuring from th face of the crank to the same point in the side of the connecting-rod brass. If the shaft is square with the guides, the distance will be the same for both positions of the crank.

Action of Receiverless Compound Engine

In a tandem-compound high-speed engine having no receiver, what becomes of the exhaust from the high-pressure cylinder after the low-pressure steam valve cuts off? *L. N. C.*

In the illustration it will be noticed that the pipe connecting the high-pressure cylinder *A* and the low-pressure cylinder *B* is of some volume and acts more



High-Speed Tandem-Compound Engine

or less as a receiver of small capacity. Taking this design as an example and assuming that the low-pressure cutoff is at one-half stroke, when the high-pressure exhaust valve opens at the end of its stroke, the pressures in the high-pressure cylinder and the connecting pipe equalize at a pressure somewhat below the high-pressure release pressure. On the return stroke the increase in the low-pressure cylinder volume causes the pressure in the high-pressure cylinder, the pipe and the high-pressure cylinder to drop. After the low-pressure cutoff the further movement of the high-pressure piston compresses the remaining steam in the high-pressure cylinder and in the connecting pipe. An indicator diagram from the high-pressure cylinder will here show a sloping line, the curvature depending upon the volume of the connecting pipe. When the high-pressure exhaust valve closes, the pressure in the pipe remains at the value existing within the high-pressure cylinder at the point when its exhaust valve closed. Continued movement of the piston causes the steam trapped in the high-pressure cylinder to be compressed, the indicator diagram showing a sharper slope to the compression line.

If there were no connecting-pipe volume, compression in the high-pressure cylinder would begin when the low-pressure cutoff occurred.

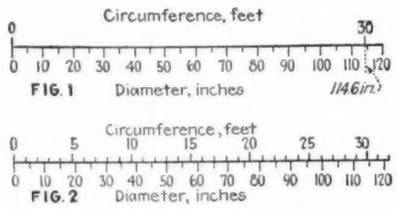
[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

Typical Examples of Single-Line Diagrams

THE article "Single-Line Diagrams," in the Feb. 26 issue, explained the general method of constructing diagrams of this type. As an illustration a diagram was constructed for turning degrees Fahrenheit into degrees Centigrade or the reverse, the finished diagram consisting of a single line with a Fahrenheit scale on one side and on the other a Centigrade scale so proportioned and located that corresponding values on the two scales came together at all points.



Figs. 1 and 2—Diagram giving relation between circumference and diameter

As another example a single-line diagram was constructed to give the relation between the weight in pounds of a certain light oil and its volume measured in U. S. gallons.

In these examples one quantity was known to be in direct proportion to the other. Both the scales were uniform in each case, so that they could be laid out by simple subdivision after two known points had been located on each scale.

To recall the method clearly to mind, a third diagram of the same type will now be constructed. Let us assume that an engineer has frequent need to know the circumference in feet of tanks whose diameter he measures in inches. The largest tank likely to be encountered is assumed to have a diameter of 120 inches.

The first step (see Fig. 1) is to draw a straight line as long as can be contained on a sheet of convenient size. The scales for circumference and diameter are labeled as shown, and the extreme values of 0 and 120 are laid down near the two ends of the diameter scale. The diameter scale is then divided into twelve equal parts with a straight-edge and celluloid triangle as explained in the previous article. This gives the divisions for 10 in., 20 in., 30 in., etc. According to the space available and the degree of precision necessary, each of these spaces is further subdivided into two, five or ten parts.

It is evident that the circumference (in any unit) must increase in exact proportion to the diameter. This being the case and the diameter scale being uniform, the circumference scale must also be uniform. Two known points are sufficient to lay out any uniform scale. The zero point must be the same on both scales. This leaves one more point to be determined on the circumference scale. For reliable and easy work this should be well toward the right end of the scale and should also be represented by a simple round number. A value of 30 ft. meets both these requirements. Since 30 ft. equals 360 in., the corresponding circumference will be $360 \div 3.1416 = 114.6$ inches.

A mark for 30 ft. circumference is therefore placed opposite 114.6 in. on the diameter scale. The space between 0 and 30 is divided into 30 equal parts, and similar divisions are extended as far as necessary to the right. The final result, after subdividing these divisions as desired, is the diagram shown in Fig. 2. This shows at once that a tank of 65 in. diameter has a circumference of 17 ft. and that a tank whose circumference is 22.5 ft. must have a diameter of 86 inches.

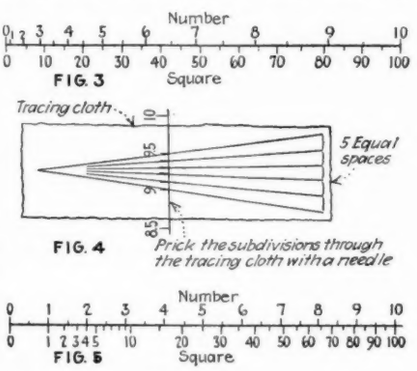
If it is desired to make a diagram that can be read more closely, a larger scale is necessary. Where the final diagram must be on a sheet of moderate size, the diagram may first be drawn on a large sheet of paper and then transferred in sections (by tracing, copying or pasting) to the final sheet. As many as ten sections of a line can easily be placed one below the other on a single sheet of letter-size paper, giving a total diagram length of about 100 in. The labor of making such a diagram is justified where the given type of problem must be solved a large number of times.

Another case that can be handled with single-line diagrams is that of a number and its square. Here it should be noted, however, that the square is not in direct proportion to the size of the number, so that it is impossible to have both scales uniformly graduated. Either one may be uniform, and the remaining one irregular or both may be irregular.

One method of constructing this diagram is shown in Fig. 3. A scale for squares is laid out from 0 to 100 with uniform divisions as shown. The divisions on the number scale must then be plotted one at a time by computation. For example, the square of 1 is 1, so these two graduations will coincide on the two scales. Again, 2 squared is 4, 3 squared is 9, etc., so 2 on the number scale will come opposite 4 on the square scale, 3 will come opposite 9, 4 opposite 16, 5 opposite 25, 6 opposite 36, etc. The same method can be used for the half marks on the number scale. For example, 6.5 squared is 42.25, which will be the point on the square scale corresponding with 6.5 on the number scale.

To subdivide any closer than this by the computation method would involve unnecessary labor. Further divisions on the number scale can be made by simply splitting each half into five equal parts. To do this quickly, a "fan" may be constructed on tracing cloth, as shown in Fig. 4, and slid back and forth until the two outer lines just wedge into the particular space being divided; the equal spaces may then be pricked through with a needle. The space undergoing subdivision in Fig. 4 is that between 9 and 9.5 on the number scale. This method may be used in any case where the spaces to be subdivided are of various lengths.

While this method of preparing the diagrams gives scales that may be easily read in the right-hand sections, the divisions are so close together in the left-hand sections that the values there cannot be read closely. This condition can be improved somewhat by making the number scale uniform, as shown in Fig. 5, although the plotting of the square scale is more difficult in this case. The 0, 1 and 100 marks can be laid out without trouble. For each of the others a square root must be taken, which is somewhat tedious unless a slide rule is handy. For example, to locate the 10 mark it is necessary to take the square root of 10. This is found to be 3.16, which is the corresponding reading on the number scale. The following divisions should be located by computations: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 35, 40, 50, 60, 70, 80, 90 and 100. Further subdivisions, if desired, can be made with the fan shown in Fig. 4.


Number
0 1 2 3 4 5 6 7 8 9 10
0 10 20 30 40 50 60 70 80 90 100
FIG. 3
Square
Tracing cloth
5 Equal spaces
FIG. 4
Prick the subdivisions through the tracing cloth with a needle
Number
0 1 2 3 4 5 6 7 8 9 10
0 1 2 3 4 5 10 20 30 40 50 60 70 80 90 100
FIG. 5
Square

Figs. 3, 4 and 5—Two ways of constructing "number-square" diagram

A more satisfactory method of constructing diagrams of this type will be explained in another article dealing with the use of "logarithmic" (slide-rule) scales.

Underfeed Stokers and Midwest Coals

IN AN ADDRESS before the Chicago section of the A.S.M.E., Jan. 15 Joseph G. Worker, president of the Stoker Manufacturers Association, advised that about 75 per cent of the

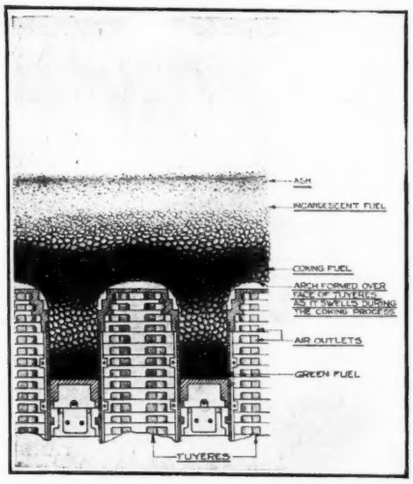


Fig. 1—Swelling of fuel produces arches over tuyeres

stokers in this country are underfeed. Interesting points concerning the operation of underfeed stokers were brought out.

The fuel bed receives its support from the walls of the retort owing to the cohesion and arching properties of the fuel, which swells during the coking process. This is fed outwardly by the retort pushers between tuyeres, Fig. 1. It is kept substantially free from the tuyere faces by arching over them. The figure also shows quite plainly the partly coked coal extending into the retorts, and an endeavor has been made to bring out clearly the arches over the tuyeres. This operating principle has been demonstrated in research work in connection with this stoker and also substantiated by expert engineering testimony.

Few have considered that underfeed stokers use arches in the combustion process similar to the way chain grates and other stokers use refractory arches. These underfeed arches are made up of partly burned coal and are continuously being burned up and reformed. Immediately over these arches of partly burned coal comes the incandescent and major fuel bed extending across the openings of the retorts. Finally, the fine ash floats on top of the entire fuel bed, as in Fig. 2. These particles are small and originally independent pieces. The feed of ash is by gravity down the slope of the fuel bed, and the movement of ash is produced by the introduction of cartridges of fuel. These cartridges give a periodical weaving movement to the fuel bed and an outward feed movement across the mouth of the retort.

The idea is often advanced that the agitation of underfeed fuel beds is not proper for a high-ash coal. A careful analysis of underfeed fuel beds will show that there is little agitation or mixing of the fuel of the kind generally supposed. These cartridges of coal are so small that the movement at the time the coal is introduced, is hardly perceptible to the eye. Arching of the fuel in the retort also relieves the pressure on these portions of the fuel in contact with the coal pushers, when they retract for another charge of fuel, so that their movement is always outward.

In its preferred operation the underfeed stoker is thus distinguishable from those forms of mechanical stokers employing inclined grates in which the feed of the green fuel is an overfeed, along the slope of the grate. This is produced by a movement of the grate bars. No grate or fuel support such as employed by overfeed or chain-grate stokers is used in underfeed stokers, the fuel instead being supported from the retorts.

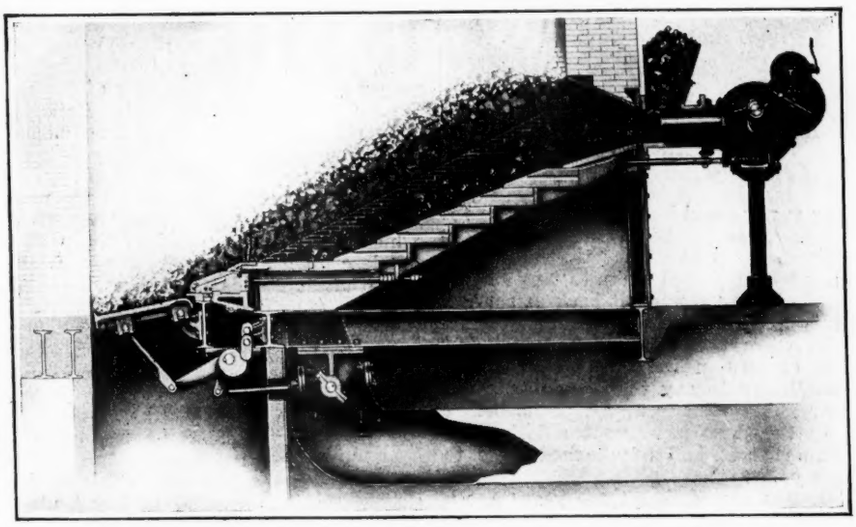


Fig. 2—Ash at the top gradually works down the sloped fuel bed

A close-up view of the surface of a fuel bed would bring out clearly the idea of the travel of the fine particles of ash down the incline of the bed. The slant of the fuel bed must be such as to effect this purpose. Impeding the ash flow tends to form clinkers.

The development work done on furnace construction for underfeed stokers has brought out side-wall air plates, air-cooled crusher plates, water backs, etc., all to the end of keeping the ash from stopping in its course down the fuel bed. Side-wall air backs are now being generally used in connection with underfeed stokers. These plates are working satisfactorily and, of course, are much better than the refractory material that was previously employed.

When multiple-retort underfeed stokers were first installed, they were equipped with dump grates, and unless this part of the stoker was handled properly, the flow of ashes would be stopped at the bridge wall. A gradual accumulation and backing up of ash would soon result in large clinkers that would not only lie on the dump grates, but would build up into the fuel bed.

Without disturbing the underfeed fuel-bed principles, the designers tackled this problem and the result was what is commonly termed the rotary ash discharge, shown in Fig. 3. This device is quite necessary for continuous and uninterrupted progress of ash and clinker from underfeed stoker fires. It is obvious that under certain conditions of operation it would not be necessary to actuate continuously the crusher in the ash well, and it is operated to keep in tune with the formation of ash as it proceeds down the slope of the fuel bed. Air-backs and water-backs are used on the front face of the bridge wall to prevent the stopping of any ash or clinker from continuing its course down through the ash wells through the crusher rolls into the ashpit.

The thing that is happening today in the West is that some of these clinker problems are being solved and we no longer fear clinkers. We are not stopping good engineering movements just because Western coals clinker.

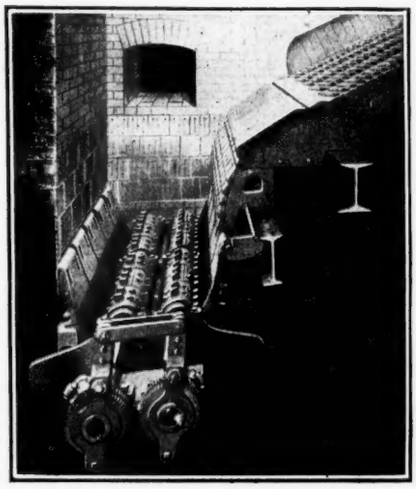


Fig. 3—Rotary grinder discharges ash and clinker continuously

Boiler Explodes While Being Tested

On Feb. 5 the explosion of a small boiler in a mill at Crider, Kentucky, according to available reports, caused the death of five men and completely demolished the section of the building housing it.

The boiler was of the locomotive type with approximately 800 sq.ft. of heating surface and had been in service for twenty years. From information obtained, it appears that the boiler had just been repaired and a test was being made before placing it back in service. It is not known what pressure was carried when the explosion occurred, but the repairman in charge of the test was heard to say that he intended to bring the pressure up to 150 lb. before he stopped, so it is reasonable to suppose that it had approached close to this point.

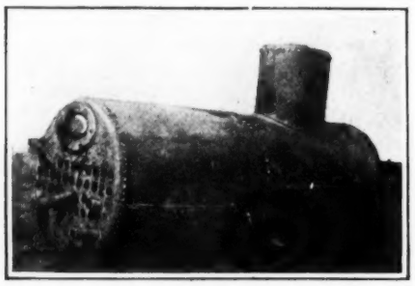


Fig. 1—Front portion of boiler blown 500 feet

It was stated that three years ago a crack developed in the fire sheet and this was welded with an oxyacetylene torch and the boiler was then brought up to 110 lb. pressure, where it showed signs of weakening. Just before the test was made that brought on the explosion, another crack had been welded together close to the old break.

Fig. 2—Section of building adjacent to boiler house

Examination of the parts of the boiler seems to indicate that the water was very low at the time of the explosion, but no definite information was obtainable. The shell parted at the throat seam and the portion of it shown in Fig. 1 was carried a distance of 500 ft. from its original location. Water for the boiler was obtained from a storage tank and was fed by a feed pump and an injector, the pump being in operation at the time of the explosion.

The boiler was not equipped with a fusible plug, and it is not known definitely whether the safety valve was in operating condition or not, nor was any information obtainable as to when the boiler was last inspected by a regular inspector or what recommendations were made at that time.

The Real Meaning of Superpower

At a joint meeting of the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of the American Society of Mechanical Engineers in the Engineering Societies Building, New York City, Feb. 27, W. S. Murray presented a paper on "The Real Meaning of Superpower and Its Relation to Railway Electrification." As to the true meaning of superpower, Mr. Murray was of the opinion that the vast majority of the public rightly interpreted its real meaning as "power better than that which had been produced in the past." In describing it as such, the speaker said that it stands for three principal things: (1) Power more adequately generated; (2) power more reliably generated; (3) power generated at a lower cost.

In order that these three procedures may be accomplished, the following principal facts must be recognized, said Mr. Murray:

1. Maximum commercial efficiency in the generation, transmission and utilization of electric energy is secured when, for minimum capital expenditure, the maximum of power adequacy and reliability, with the highest operating economy, is reached.

2. Minimum steam generated electricity is secured when there is associated with it the maximum of water-power generated electricity.

3. The greater the interconnection between steam-electric and hydro-electric plants the greater the opportunity of producing hydro-electric energy.

4. Power can now be reliably transmitted, using potentials as high as 220,000 volts, which pressure doubtless in the future will be exceeded. With potentials of this order the economic radius of power transmission has increased in a few years from less than 100 to over 300 miles.

"Therefore, it follows from (1), (2), (3) and (4) that maximum economy in electric power production will be secured through co-ordinate regional expansion of the electric utilities and I would add, *under public regulation.*"

In speaking of why there had not been a greater application of electricity in the field of heavy railway work, Mr. Murray said: "I believe I can present two principal reasons why this has been so, and in the order of their degree, I would mention the first as a lack of credit on the part of the railroads to finance the electrical investment necessary, and the second, where the first reason does not exist, then because of the old dispute as to the kind of electrification system. Regarding the latter, railroad management has taken the position that if the electrical manufacturers cannot agree as to what system should be used, they (the railroads) are in no position to decide it for them, and notwithstanding the fact that either system—the direct-current or the alternating-current—in many cases would be far the better one for them than steam, they will not and could not, under conflicting opinion on the part of those who should know and agree, settle this question.

"The advent of superpower stations, carrying with it the opportunity of supplying adequate, reliable and economic power to the railroads, either directly from their buses or through the means of economic high-tension transmissions to points on their right of way, will infuse into railroad management incentive to now go ahead with the electrification of those divisions where either on account of economic consideration or the clearing up of traffic at congested points justifies it.

Compares Advantages of Alternating and Direct Current

"Twenty years of electric railroading have established in my mind two conclusions: The first, that as in the instance of preference for alternating current in the matter of transmission and distribution for commercial and lighting purposes, similarly, this type of high-tension current is logically applicable for transmission to and distribution in the circuits associated with railway electrification; the second, that, viewed from the standpoint of reliability of operation and economy in maintenance, the direct-current motor employing potentials not exceeding 1,500 volts is superior to any form of alternating-current motor so far applied to the driving axle of locomotives or cars. . . .

"Let me again remind you that the prosperity of this nation is absolutely dependent on adequate, reliable, economic power production and transportation. The more we throw either into the hands of government or municipal ownership the more we inhibit our prosperity. On the contrary I believe that public regulation of both is essential to that same prosperity. State and federal machinery has been created for that purpose and is available. Very probably it can be improved but the principle is *right*. We want less legislation for new laws and more legislation for improving those we have."

The Royal Electrification Commission of Sweden has issued a report advocating the electrification of the whole of Sweden, according to the *Christian Science Monitor*. The normal yield of Sweden's water power is estimated at 32,500,000,000 kw.-hr. per annum, of which close upon half, or 15,000,000,000 kw.-hr. comes upon the "power province" of Upper Norrland, about 10,000,000,000 kw.-hr. on Nether Norrland, and only 7,500,000,000 kw.hr. upon the "power province" of central and southern Sweden, where the principal power consumption is located.

Boulder Dam Will Have Ample Water for Power, Says Hoover

Commerce Secretary Hoover sees nothing practical in the point made by Representative Raker, of California, as to the power of the federal government to control sufficient water at the proposed Boulder dam to operate the hydro-electric plant, which forms an important part of the project. He fears that, should there be a period of low water, the available supply would be held back for agricultural purposes and the plant stopped. Secretary Hoover's comment on that point is:

'The volume of water is so ample that there would be no danger in this initial construction of any impairment of the power flow. Every further development of the river for power would reinforce further the power situation at Boulder Canyon."

In that connection, Mr. Hoover discussed the Colorado River compact and expressed the opinion that Arizona's decision whether or not to ratify the compact would be determined at the next state election. "The Colorado River compact is approved by the majority of the people in Arizona," said Mr. Hoover. "There was a great deal of improper confusion as to the meaning of the compact. There was a great deal of misconception. Unfortunately, politics crept in in Arizona. It was the only state in which politics did enter into the ratification of the compact. How far the power question has entered into stopping the legislation for ratification in Arizona, I could not say. The Upper Basin states have just claim for full protection. As a matter of justice that protection must be provided for them and for their future before this construction proceeds."

Criswell Scores Power Companies

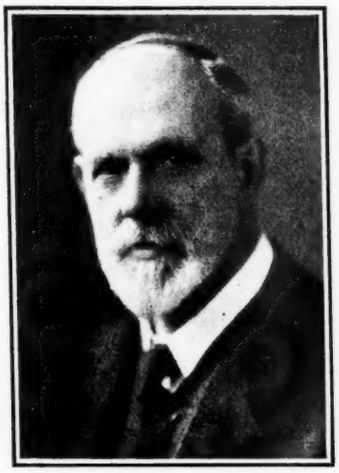
Ralph L. Criswell, a member of the city council of Los Angeles, testified before the committee on Feb. 27. He declared that the power companies had been active in their opposition to the bond issue intended to expand the city's hydro-electric activities. He said the power companies would like to see Los Angeles secure rights at small high-cost power sites while they would concentrate their efforts to the securing of lower-cost power on the Colorado, thus leaving the municipality at a disadvantage in its effort to furnish power at the lowest possible cost.

Mr. Criswell advocated the immediate construction by the government of the Boulder Dam and expressed the opinion that a reservation could be written into the law which would fully protect the upper basin states.

It is the plan of Chairman Smith, of the Irrigation Committee of the House of Representatives, to have George L. Hoxie appear just prior to the closing of the hearing. Since other charges against the power companies likely will be made during the course of the hearings, he thinks it will be well to have Dr. Hoxie to attempt to refute them all at one time, Mr. Smith explained.

W. H. Patchell Heads English Mechanical Engineers

William Henry Patchell, consulting mechanical and electrical engineer, was recently nominated as president of the Institute of Mechanical Engineers (England). A nomination is usually regarded as equivalent to an election in this society which had its formal e'ection in February.



William Henry Patchell

Mr. Patchell, who was born in 1862, was apprenticed early in life to Robey & Co., Lincoln, as an engineer, and later became works manager for the electrical Power Storage Co., Ltd., Millwall E., where he remained five years. In 1893 he became engineer-in-chief of the Charing Cross, West End & City Electric Supply Corp., Ltd., where he remained until 1906, when he established a practice as consulting engineer.

A member of the Institute of Civil Engineers, and Institute of Mining Engineers, Mr. Patchell has also been vice-president of the Institute of Electrical Engineers for two separate terms, 1904-07, 1909-12.

Among the more important papers published by him are: "Steam Superheating"; "City of London Works of the Charing Cross Co."; "Electrification of the Ferndale Colleries"; "Power Stations"; "Gas Producers."

Public Service Co. of Colorado Enlarging

The Public Service Company of Colorado will spend approximately $40,000 during the year for improvements in its Denver steam-heating plant; about $800,000 will be used to improve and enlarge its electrical plants; $1,341,886 will be necessary to take care of the fast growing gas business.

Gennevilliers To Use Pulverized Coal

In the new extension to the Gennevilliers station of the Union d' Electricite, the boilers will be fired with pulverized coal. Orders for the new equipment have already been placed with Vickers, Ltd., and International Combustion Engineering Corp., London, England.

The new equipment will include four 19,500-sq.ft. boilers of the Ladd-Belleville type designed to operate at 440 lb. pressure and a normal rating of 150,000 lb. of steam per hour, eight Lopulco gravity coal driers, eight Raymond roller mills of 6 tons capacity each, and forty-eight Lopulco variable-speed feeders and also burners of the fishtail type. The combustion chamber of each furnace will be constructed with air-cooled walls and fitted with Lopulco water screens.

San Francisco Asks Valuation of Power Companies

The City of San Francisco has asked the Railroad Commission to fix a just compensation to be paid by the city for those portions of the electric generating, transmission and distributing properties of the Pacific Gas & Electric Co. and the Great Western Power Co., which the city desires to take over and utilize in the distribution of power from the Hetch Hetchy water and power project. The petition sets forth that the City of San Francisco is now engaged in the construction of the Moccasin Creek power plant and that it desires to transmit the power generated to San Francisco for distribution. For the purpose of distribution it is necessary for the applicant to acquire the lands, steam generating plants, substations, distributing systems and other properties now owned by the two power companies, under eminent domain proceedings, or otherwise.

The properties which the city proposes to acquire and those it intends to exclude are itemized. The application is accompanied by a properly attested resolution of intention to acquire these properties by condemnation proceedings.

New York State Water Power Legislation Still Matter of Controversy

Governor Smith and Speaker Machold Unable to Arrive at Agreement

GOVERNOR SMITH and Speaker Machold, of New York State, have clashed again in regard to legislation on water power. Following a conference between the two men recently, it became known that every prospect of an agreement with regard to water-power legislation had vanished. The Governor's water-power bill was introduced in the Senate and Assembly, Feb. 28, and at the same time there was presented in both branches of the Legislature a bill embodying the views of the Republican leaders.

The two measures differ chiefly in that the Governor's bill will define a state policy with regard to water-power development while the Republican measure will provide for the creation of a Waterpower Authority, akin to the Authority of the Port of New York, which for the next year would have no power except to make a preliminary survey of the state's resources and methods of development. For that purpose an appropriation of $100,000 is provided.

According to press reports in Governor Smith's bill:

"The Authority is given full power to develop the power resources available for the generation of hydro-electric energy upon the Niagara and St. Lawrence Rivers and upon inland streams and waterways now owned by the state, and for this purpose may issue bonds for financing such development, these bonds to be exempt from state taxation and to be secured entirely by the revenues derived from operation, without involving any pledge of the state's credit.

"To enable the trustees to arrange such financing, the Authority, as a public corporation, is vested with title to all undeveloped water powers on these rivers, streams and waterways to which the state has any right, title or interest by reason of its ownership of the beds or banks, and the bill expressly provides that these power resources and the sites, works and improvements established or undertaken, in the development of these resources shall always remain under the ownership and control of the Authority for the benefit of the people of the state, and shall not be sold, conveyed, exchanged or leased to any person or private corporation."

The portion of Governor Smith's bill to which the Republican leaders objected is the following clause:

"The natural resources available for the generation of hydro-electric energy in connection with the Niagara and St. Lawrence Rivers and in connection with inland streams and waterways now owned or hereafter acquired by the state shall forever remain the property of the people of the state. The sites, works, developments and improvements established or undertaken by the state in connection with such resources shall not be sold, leased, exchanged or conveyed to any private corporation, individual or agency, but shall always continue under public control."

Objections were also raised by the Republicans against a proposal by Governor Smith for the repeal of the Miller water-power law, now in force, but inoperative under an agreement with the Water Power Commission that no leases of water-power sites shall be awarded to private interests until a fixed policy for the state has been adopted.

Pulverized Coal Equipment Ordered by Belgium Firm

An order has been placed recently with Vickers, Ltd., and International Combustion Engineering Corp., of London, England, for boilers and pulverized-coal equipment for the new power plant of the Societé Metallurgique de Hoboken near Antwerp. A similar order was placed some time ago for equipment for a power station at Charbonnages de Beeringen in Limbourg.

Prefers Steam to Water Power in Colorado

In an address before the Denver Section of the American Institute of Electrical Engineers, V. L. Board, general superintendent of the Public Service Company of Colorado, told of the many inroads, byways and highways necessary in the building of the $12,000,000 power plant at Valmont. Some surprise being expressed over the fact that the company had not selected a hydro site in that vicinity, the speaker explained that "steam is so dependable, so easily harnessed and so powerful, and of course there is coal and water in abundance."

Canada Will Probably Favor St. Lawrence Project

Press reports state that the Canadian Government has reversed its attitude on the St. Lawrence deep waterway scheme and according to semi-official information will intimate that it favors not only deepening the St. Lawrence, but also the development of power on the river. It is hinted that the Liberal party will endeavor to return to power on this policy.

The decision taken by the government so far as regards the development of power is said to be due to a desire to please Ontario. The Province of Quebec is antagonistic to the St. Lawrence deep-waterway scheme and also to the power scheme.

The government appears to be strongly influenced by the impression that it must do something with respect to the power situation on the St. Lawrence, and at the same time it is convinced that the United States government will hardly give its consent unless the navigation feature is included.

Public Utilities Bill Before New York Legislature

The Public Utilities control bill which John H. Delaney, former Transit Commissioner, has been drafting, made its appearance before the New York State Legislature on Feb. 21.

The bill amends the general city law in relation to ownership, construction, acquisition and operation of public utilities. The first part of the measure provides workable machinery for acquisition of utilities; the latter part describes the method by which such plan is to be put into operation.

Under this proposed plan the city would provide the purchase money for the equipment, plant, facilities, etc., and also provide a fund sufficient to pay the operating expenses, including the wages of all employees for the first six months of operation of the utility, and would also be enabled to appropriate for a second payroll. The act, should it be enacted into law, would take effect immediately.

The date of a public hearing on this measure has not yet been announced.

Sweden's Power Production Analyzed

Sweden's significant changes in fuel consumption and power production since 1913 have been the subject of statistical investigation by Axel F. Enström, government commercial counselor, whose findings have just been made public. A decided increase in the development of hydraulic power and in the imports of gasoline and fuel oil, are salient points in Mr. Enström's report.

For purposes of this report the average for the years 1913-16 were compared with the averages for 1919-22. In this comparison coal imports show a fall from 5,500,000 tons per annum to 2,600,000 tons. Meanwhile the imports of gasoline have risen from 13,000 tons per annum to 43,000 tons, and motor oils from 17,000 tons to 44,000 tons. On the other hand, illuminating oil shows a fall of 43,000 tons from the average imports of the first of the two periods compared, and lubricants fell 2,000 tons. Therefore Sweden's total petroleum imports are about the same in volume now as during the first years of the war.

Examining the native Swedish sources of power, Mr. Enström says that the production of peat has developed from 150,000 tons per annum to upward of 500,000 tons. Hydraulic power has also been developed rapidly, and there has been an improvement of 50 per cent in the production and use of electricity. The total increase in motive power during the ten-year period is about 700,000 hp., of which 600,000 hp. is used by water-driven machinery. Commenting on the use of shale for fuel, Mr. Enström says that statistics for the early years are not available. During 1921 there was 268,000 tons of shale produced, but the amount of shale oil at present produced per annum is probably not more than 3,000 tons.

According to this report the total consumption of fuel in Sweden has

been reduced to 70 per cent of the figure for 1913-1€ About half of this reduction is to be accounted for by the decrease in industrial production and the rest to a corresponding use of electricity.

France Regains Pre-War Coal Production Level

France has recovered its "pre-war coal level," according to L. P. Hornberger, European representative of the Lake and Export Coal Corp. of New York, and the American representative of the French Steel and Iron Importers, Norttrilor who arrived recently in New York.

"France," said Mr. Hornberger, "is now back to her pre-war level of coal production, mining 40,000,000 tons a year." He said this was most interesting, as a board of engineers following the war and examining into France's losses, stated that it would take 20 years for France to reach her pre-war coal production level.

California Water and Power Act To Come up Again

It is now definitely known that the Water and Power Act will come up again this year in California. The act is designed to place the light and power industry of the state under public ownership. An initiative petition to place the measure on the ballot will be circulated in the near future. It is understood that the act will be almost identical with the 1922 measure. The original act provided for the issuance of bonds up to an amount of half a billion dollars for the purpose of constructing, purchasing or condemning light and power systems in the state. The administration of the act was to be in the hands of a board of five to be appointed by the Governor. When the measure came up at the election in November, 1922, it was defeated by a vote of about three to one.

Canadian Committee Plans for World Power Conference

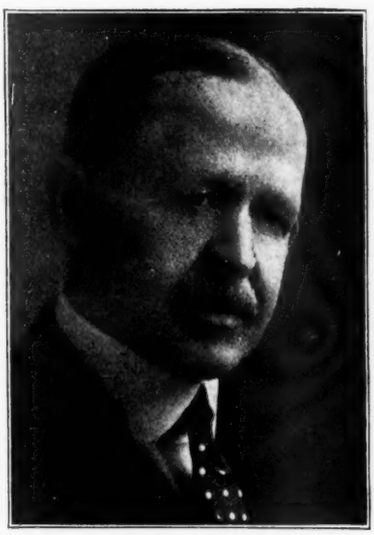
The Canadian Committee is making plans for the participation of Canadian engineers in the World Power Conference which is to be held in connection with the British Empire Exposition at Wembley, June 30 to July 12. A tentative program of the Canadian Committee is now being prepared, and the details will be made public shortly.

The Canadian Pacific steamship "Empress of France" has been chosen to carry the Canadian party of delegates, their families and friends from Canada to England. This steamship will sail from Quebec at 3:30 p.m., June 18, and is due to arrive in Southampton on June 25. A few tentative reservations for the Canadian Committee has also been made on the new cabin-class oil-burning steamship "Montclare," which will sail from Montreal on June 20, arriving at Liverpool on June 27. The Canadian Committee has offered the American Committee facilities for any American delegates, or their friends, who desire to travel by the St. Lawrence route, on the "Empress of France."

John Washington Lane Died on February 25

John Washington Lane, for 21 years editor of the *National Engineer*, died on Feb. 25 at the home of his sister in Lowell, Mass.

Mr. Lane was born in Portland, Maine, Feb. 19, 1868, his father being a Civil War veteran and an active labor leader. In 1872 his parents moved to Boston, where he attended the Lowell school in the Roxbury district, graduating in 1882. Two years later, when he was sixteen years old, he moved to Providence, where for three years he worked under the instructions of a careful and studious engineer who believed that a thorough knowledge of the fundamental principals of engineering were necessary for an engineering



John Washington Lane

career. Following these periods of training he was successively engineer for John A. Hogland, the Narragansett Collar Co., Charles H. Field, Collyer Machine Co., the Allendale Mills, the *Providence Journal*, and finally chief engineer of the Eaton estate, of Providence. Mr. Lane became a member of the N.A.S.E. in 1889, was elected trustee of No. 1 in 1892, national vice-president in 1893, and national president in 1894.

In December, 1899, Mr. Lane accepted a position as editor of the *Engineer's List*, a publication circulating among engineers in New York and vicinity. He remained in this position until December, 1901. Five months later he accepted the editorship of the *National Engineer*, with which he was associated until shortly before his present illness. His accumulated engineering knowledge and familiarity with the many angles of association work was largely responsible for the continued and increasing success of the publication as the years went by. The members of the N.A.S.E. will miss his genial presence at their association meetings.

Natural Steam Wells Supply Light and Power

A third steam well is being drilled about a half-mile from the two wells already in operation in the region called "Dev'l's Gulch," Sonoma County, Calif., where natural steam has been successfully used for electric current for light and power. The third well is expected to supply the town of Healdsburg, 23 miles distant, with sufficient current for lighting and heating. It is anticipated that the well will yield about 2,500 horsepower.

The area of the subterranean reservoir from which the steam is being drawn is supposed to be a half a mile wide by ten miles long, or 3,200 acres in extent.

According to the *Supplement* to *Commerce Reports* future requirements of marine and stationary crude-oil and gas engines, in Greece, are not being filled, pending an improvement in exchange conditions. American manufacturers should prepare for a future demand by putting their makes on exhibition in local showrooms, which are readily held at their disposal by the larger engineering firms. This selling method is now firmly implanted in the local trade as the only one giving satisfactory results.

Water-Power Projects

Hydro-Electric Project in the Straits Settlements—A project is being actively considered for the harnessing of the Perak River for the development of electric energy. An English company is now making surveys and will report the result of its findings to the government in the near future. It is stated that such an undertaking would offer a favorable opportunity for the participation of American manufacturers of construction material and equipment, according to *Commerce Reports*.

Flathead Lake, in northwestern Montana, is well situated for storage of water for power development or for irrigation, according to a report of government engineers made public by the Department of the Interior. The area draining into the lake, the report says, is about 7,010 square miles and the mean annual discharge from the lake is about 8,330,000 acre-feet. At low water the elevation of the lake is 2,882 ft. above sea level with an area of 120,000 acres. There is no artificial regulation of the lake at present.

Pitt River No. 3 Plans Changed.—Plans for the dam to be constructed in connection with the development of the Pacific Gas and Electric Co. Pitt River No. 3 project have been approved by the Federal Power Commission. The plan just approved was submitted after an earlier one had drawn objections from the commission's engineers. The first plan provided a rock-filled dam; the new one calls for a concrete dam. The commission also questioned the watertightness of the reservoir at the site selected by the company. In the new plans steps are taken to insure against any such failure.

Society Affairs

The Chicago Section of the A.I. & S.E.E. will hear a lecture on "Combustion," by G. R. McDermott at its Mar. 14 meeting.

The Metropolitan Section of the A.S.M.E. will have "Roller Bearings," as the topic of its Mar. 11 meeting, which is to be held in Newark, N. J.

The Metropolitan Section of the A.S.M.E. will have as the subject of its March 6 meeting "Electric Elevators." D. L. Lindquist will be the speaker.

The New York Chapter of the A.S.H.V.E. will hold a meeting on March 17 at the Building Trades Club. The subject for discussion will be "Professional Ethics."

The St. Louis Section of the A.S.M.E. publishes a "History of the American Society of Mechanical Engineers," by Lehigh University, in the December number of *The Forge*, its official bulletin.

The Atlanta Section of the A.S.M.E. will hear A. F. Greaves-Walker, president of the American Ceramic Society, speak on "Refractory Materials in Steam Boilers and other Industrial Furnaces," at its March 21 meeting.

The Mountain States Ice Manufacturing Association, at its tenth annual convention, held in Denver recently, elected William Kelly, of Greeley, Colo., president; E. L. Titus, Sterling, Colo., vice-president and W. B. Storer, Pueblo, Colo., treasurer.

The Franklin Institute of Pennsylvania will hear a lecture by Eskil Berg, General Electric Co., Schenectady, N. Y., on "Pressure, Superheat and Reheating as Affecting Power-Plant Economy," on March 19 in the lecture room of the Institute at Philadelphia.

The Institute of Metals at its general annual meeting to be held in London Mar. 12-13, will hear a paper by W. E. W. Millington and Prof. F. C. Thompson on "The Investigation of a Fatigue Failure of Brass Tubes in a Feed-Water Heater—with a Consideration of the Nature of Fatigue."

The Fuel Saving Conference of the **Association of the Iron and Steel Electrical Engineers,** to be held in Pittsburgh, at the Wm. Penn Hotel on April 2-3, has announced its tentative program as follows:

Boilers—"Prevention of Scale Formation by Boiler Water Conditioning," by Dr. R. E. Hall, U. S. Bureau of Mines, Carl Fisher, Mesta Machine Co., and George W. Smith, Hagan Corp.; "Measurements of Input and Output of Boiler Rooms," by J. M. Spitzglass, Republic Flow Meters Co.; "Ljungstrom Air Preheater," by B. G. Brolinson, Aktiebolaget Ljungstrom Angturbin, Wellsville, N. Y.; Topical Discussion "Coal Losses Due to Stand-by Steam Requirements and Demands."

A session on "Heating Furnaces" and inspection trips to the power plant of Jones & Laughlin Steel Corp. and Allegheny County Steam Heating Co. are also on the program.

Coming Conventions

American Association of Oil Burner Manufacturers. No. 518 Bank of Galesburg Bldg., Galesburg, Ill. First annual meeting at Hotel Chase, St. Louis, Mo., April 1-3.

American Electrochemical Society. C. G. Fink, Columbia University, New York City. Meeting at Hotel Bellevue-Stratford, Philadelphia, Pa., April 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Spring convention at Birmingham, Ala., April 7-10.

American Society of Civil Engineers. John H. Dunlap, 29 West 39th St., New York City. Spring meeting at Atlanta, Ga., April 9-12.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Cleveland, Ohio, May 26-29.

American Water Works Association. J. M. Diven, 153 West 71st St., New York City. Annual convention at New York City, May 19-21.

Association of Iron and Steel Electrical Engineers. W. M. Chandler, 708 Empire Building, Pittsburgh, Pa. Fuel Saving Conference—Combustion Engineers. April 2-3 at Wm. Penn Hotel, Pittsburgh, Pa.

Electric Power Club. S. N. Clarkson, Keith Bldg., Cleveland, Ohio. Meeting at Seaview Golf Club, Absecon, N. J., May 26-29.

International Railway Fuel Association. J. B. Hutchinson, 6000 Michigan Ave., Chicago. Annual convention at Hotel Sherman, Chicago, Ill., May 26-29.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Meeting at Chicago, May 20-23, 1924.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Kansas Association** at Parsons, Kans., April 16-18. J. M. VanSant, 739 Horne St., Topeka, Kan. **Indiana Association** at La Fayette, Ind., May 5-6. Prof. A. W. Cole, Purdue University, Lafayette, Ind. **New Jersey Association** at Newark, June 6-8. Joseph P. Flynn, 612 Franklin St., Elizabeth, N. J. **Iowa Association** at Sioux City, June 10-14. Abner Davis, 16 Waterhouse Block, Cedar Rapids, Iowa. **Ohio Association** at Akron, June 19-21. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at Bridgeport, Conn., June 27-28. George F. Klopfer, 30 East Pearl St., New Haven, Conn. **New England States Association** at Cambridge, Mass., July 10-12. Freeman L. Tyler, 32 Briggs St., Taunton, Mass. **Minnesota Association** at Fairbault, Minn., July 31, Aug. 1-2. C. A. Nelson, 800 22 Ave., N. E. Minneapolis. **Michigan Association** at Grand Rapids, Sept. 8. Wm. H. Yeomans, 209 Plainfield Ave., Grand Rapids.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 11-14, 1924.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St. New York City. Annual convention at Atlantic City, Young's Million-Dollar Pier, May 19-24. **Nebraska Section,** H. M. Davis, Banker's Life Bldg., Lincoln, Neb. Sectional meeting at Omaha, May 8-9. **Southwestern Division,** S. J. Ballinger, San Antonio Public Service Co., San Antonio, Texas. Divisional meeting at New Orleans, April 22-25.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Buffalo, N. Y., April 30 to May 2, 1924.

Business Notes

The Conveyors Corporation of America, Chicago, Ill., manufacturers of coal- and ash-handling equipment, announces that its Omaha district representative, the Kent Engineering Co., has changed its address from 504 First National Bank Bldg., to 1110 Farnum St., Omaha, Neb., and that its Connecticut representative, the J. B. Engineering Sales Co., has moved its offices from Hartford to New Haven, Conn.

The Twinvolute Pump & Manufacturing Co., of Newark, N. J., has recently been acquired by the John H. McGowan Co., of Cincinnati, Ohio. The McGowan Co. will add the new line to its other line of steam pumps. John B. Ketcham, formerly representative for the Twinvolute Pump and Manufacturing Co., will continue to represent the Twinvolute line in the Metropolitan district. He will also handle the La Bour self-priming centrifugal pump.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Feb. 18, † 1924	Feb. 25, 1924
Pool 1	New York	$3.25	$3.25
Smokeless	Columbus	2.25	2.25
Clearfield	Boston	2.25	2.40
Somerset	Boston	2.50	2.65
Kanawha	Columbus	1.75	1.75
Hocking	Columbus	2.00	2.00
Pittsburgh No. 8	Cleveland	1.85	1.85
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.75	2.75
West Ky.	Louisville	1.90	1.90
S. E. Ky.	Louisville	2.00	2.00
Big Seam	Birmingham	1.85	1.85

FUEL OIL

New York—Feb. 29, light oil, tank-car lots, 28@34 deg. Baumé, 5c. per gal., 36@40 deg. 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Feb. 19, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.95@$2 per bbl.; 26@28 deg., $2@$2.05; 28@30 deg., $2.05@$2.10; 32@36 deg., gas oil, 5½c. per gal.; 36@38 deg., distillate, 6½c. per gal.; 38@40 deg., 7½c. per gal.

Pittsburgh—Feb. 19, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., fuel oil, 6c.; 34 deg., neutral 10c. per gal.

Cincinnati—Feb. 25, tank-car lots, f.o.b. local refinery, 26@30 deg. Baumé, 6¼c. per gal.; 30@32 deg., 6¾c.; 38@42 deg., distillate, 7½c. per gal.

Dallas—Feb. 23, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Philadelphia—Feb. 23, 28@30 deg., $2.31@$2.36 per bbl.; 18@22 deg., $2.10@$2.16½; 13@16 deg., $1.68@$1.74½ per bbl.

Boston—Feb. 19, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 6¼c. per gal., light oil, 28@32 deg. Baumé, 4¼c. per gal.

Chicago—Feb. 18, 24@26 deg., $2.12 per bbl.; gas oil, 32@36 deg., 4.93c. per gal.

New Plant Construction

Ala., Birmingham — The Southern Railway Co. has completed plans for the construction of a one-story power house, 80 x 90 ft., at its proposed local shops at Finley and Emily Avenues. The entire plant will cost close to $3,000,000. Dwight P. Robinson & Co., Inc., 125 East Forty-sixth Street, New York, is engineer.

Ark., Ashdown—W. L. Moody, Little Rock, Ark. has acquired the local electric light and ice-manufacturing plant of the Commonwealth Public Service Co., and is reported to be planning for extensions and improvements.

Ark., Magnolia—The Columbia Cotton Oil Co. is said to be planning for the construction of a boiler house, and the rebuilding of the portion of its cottonseed oil mill, recently destroyed by fire with loss estimated at $125,000.

B. C., Vancouver—John Hanbury, Vancouver, has secured a franchise from the city for the construction and operation of a central boiler and heating plant, and will have plans drawn at an early date. It will cost in excess of $100,000, with equipment. It is proposed to organize a company to operate the station.

Calif., Fullerton — The Balboa Motors Corp., care of George A. Raymer, general manager, Chamber of Commerce, plans for the construction of a boiler plant at its proposed local automobile assembling works, estimated to cost $125,000.

Calif., Gilroy—The Board of City Trustees plans for the installation of electric-operated pumping equipment in connection with proposed extensions to the waterworks, estimated to cost $87,000.

Calif., Glendale—The National Ice Co., Postal Telegraph Building, San Francisco, has filed plans for the erection of a one-story ice-manufacturing plant at 456 San Fernando Road, for which work will be placed under way at once.

Calif., Los Angeles—F. A. Maginnis is having plans prepared by the Gay Engineering Co., 2650 Santa Fe Avenue, for the construction of a one-story ice-manufacturing plant, 117 x 120 ft., on Third Street, near Westmoreland Avenue, estimated to cost $125,000, with equipment.

Calif., Orland—The Board of City Trustees is arranging for a bond issue for the purchase of the local electric plant and system of the Pacific Gas & Electric Co. to be operated in the future as municipal property. Extensions are planned, with additional equipment.

Calif., Oroville—The Pacific Gas & Electric Co., 445 Sutter Street, San Francisco, will install a 500 gal. per min. booster pump, motor-driven, and auxiliary equipment, in connection with a new 300,000 gal. capacity reservoir on local site.

Calif., Riverside—The Riverside Cement & Asbestos Mfg. Co. plans for the construction of a steam power plant at its proposed cement mill and asbestos products factory at the Eden Hot Springs, estimated to cost close to $500,000, with equipment.

Calif., San Francisco—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will take bids until March 11, for 2,600 lbs. of condenser tubes for the Mare Island navy yard, as set forth in Schedule 1920. Also, until March 18, for 307,000 manhole boiler gaskets for the Mare Island and Puget Sound, Wash., yards, as per Schedule 1931.

Calif., Uplands — The Standard Rock Crushing & Gravel Co. plans for the construction of a power house at its proposed rock-crushing plant on Fourteenth Street, near the city limits, estimated to cost $300,000.

Calif., Woodland—The Union Ice Co., 354 Pine Street, San Francisco, is planning for the erection of a local ice-manufacturing plant, estimated to cost close to $50,000.

Colo., Colorado Springs—The Glockner Sanatorium will erect a boiler and laundry plant to cost about $140,000. Sister Mary is the superior for the sanatorium.

D. C., Washington—The general purchasing officer, Panama Canal, will take bids until March 6, for valves, cocks, steam traps, bends, pipe and fittings, and other equipment as specified in Circular 2346. Also, until March 13, for pumps, valves, fittings, brass checks, washers, etc., as per Circular 1592.

D. C., Washington—The United States Army Department has authorized the installation of oil-operated engines for the pumping plant at Fort McKinley, for which bids will soon be asked by the constructing quartermaster.

Egypt, Cairo—Bids are being asked by a company at Cairo until March 31, for four internal combustion engines, each direct-connected to a centrifugal pump, with capacity of about 100 cu.ft. per second. Name of company and specifications on file at the New York district office of the Bureau of Foreign and Domestic Commerce, 724 Customhouse, file reference No. 120385.

Fla., Madison—The Town Council has approved plans for the installation of an ice-manufacturing plant in connection with the municipal power station, and will take equipment bids at once. S. P. Griffin is town clerk.

Fla., Sanford—W. B. Williams, city manager, will receive bids until March 10, for equipment for a municipal waterworks, including pumping station and complete pumping machinery and auxiliaries, with 200,000 gal. capacity steel tank on tower. Joseph E. Craig, 427 King Street, Jacksonville, Fla., is engineer.

Fla., Tampa—The United States Export Chemical Co., will soon commence the construction of its proposed local phosphate and fertilizer plant, with power house and pumping station, estimated to cost $1,200,000. The Chemical Construction Co., Charlotte, N. C., Peter S. Gilchrist, president, is in charge.

Ga., Thomasville—The Board of Trustees, Archbold Memorial Hospital, will construct a boiler house and refrigerating plant, with mechanical laundry, at the proposed local institutional buildings, to cost about $1,000,000. Bids for the structures are being asked, and estimates for mechanical equipment will be called in the near future. E. C. Wachendorff, 620 Forsyth Building, Atlanta, Ga., is architect.

Ill., Bellwood—The Village Council plans for the installation of a pumping plant in connection with a new sewerage system to cost about $200,000. Edgar A. Rossiter, 127 North Dearborn Street, Chicago, is engineer.

Ill., Downers Grove—The Illinois Public Service Co. has acquired the local municipal electric plant and system, and will consolidate with its properties. Extensions are planned in this section.

Ill., Glenview—The Common Council is considering the installation of a pumping plant for the proposed municipal sewerage system, estimated to cost $100,000. The Marr-Green Co., 400 North Michigan Avenue, Chicago, is engineer.

Ill., Litchfield — The Citizens' Waterworks, Inc. will receive bids until March 26, for equipment for a new pumping station and filtration plant, including three steam-driven centrifugal pumps, and two boiler feed pumps; two 200 hp. fire tube boilers, and auxiliary apparatus. Pearse, Greeley & Hansen, 39 West Adams Street, Chicago, are engineers.

Ind., Jeffersonville—The United States Army Department, Washington, D. C., has authorized the installation of a water-softening plant at the local depot, for which bids will soon be asked by the constructing quartermaster.

Iowa, Eagles Grove—The Common Council is considering a special election to vote bonds for $150,000, for the installation of a municipal electric light and power plant. J. K. Baker is city clerk.

Kan., Fort Riley—The United States Army Department, Washington, D. C., has authorized the installation of additional boilers and auxiliary equipment at the local station, for which bids will soon be called by the constructing quartermaster.

Kan., Fredonia—The city has retained Arthur L. Murrergren, consulting engineer, Gates Building, Kansas City, Mo., to prepare plans and specifications and supervise the construction of its municipal electric light plant, electric distributing system and electrification of the water pumping plant. Bonds to the amount of $150,000 have been voted for these improvements.

Kan., Independence—The Crystal Ice & Fuel Co. has completed plans and will commence the construction of a one-story cold storage plant, with foundations to provide for the addition of two more stories later, 60 x 140 ft. Hans Von Unwerth, Finance Building, Kansas City, Mo., is engineer. A. B. Shafer is general manager.

Ky., Olive Hill — The Common Council has preliminary plans under advisement for the installation of electric-operated pumping machinery in connection with a proposed waterworks and sewerage system.

La., Plaquemine—The Plaquemine Box & Veneer Co. is considering the construction of a boiler plant at its proposed local veneer mill and box-manufacturing plant, to cost in excess of $50,000. R. I. Schwing is president.

Md., Baltimore—The Board of Public Works has tentative plans under advisement for the construction of a municipal boiler and heating plant, estimated to cost close to $250,000. W. F. Stone, Jr., Munsey Building, is architect.

Md., College Park, Baltimore—The State Legislature is considering an appropriation of $765,000 for additional buildings at the University of Maryland, to include a steam power station to cost $75,000, and mechanical laundry, estimated at $30,000. The Board of Trustees will be in charge.

Mass., Brockton—The Edison Electric Illuminating Co., is reported to be planning for enlargements in its power plant. The company has recently arranged a bond issue of $1,064,250, portion of the fund to be used for extensions.

Mass., Fall River—The Durfee Mills, Inc. has superstructure work in progress on a new steam power house on Pleasant Street, for use at its textile mill, to cost about $45,000, for which plans were drawn by the Henry R. Kent Co., 10 Erie Street, Rutherford, N. J., engineer.

Mass., Lowell—The Redman & Russell Lumber Co., Canada Street, has tentative plans for the rebuilding of the portion of its boiler house and lumber plant, destroyed by fire, Feb. 18, with loss reported at $45,000.

Mich., Belding—The Belding Hall Co., are having plans prepared for a 675 kw. steam power plant. Burd & Giffels, Grand Rapids, Mich., are the engineers.

Mich., Detroit—The Pittman & Dean Co., Hastings and Trombley Avenues, will commence the construction of a one-story ice-manufacturing plant 100 x 250 ft., at Mack Avenue and the Belt Line Railroad, estimated to cost $200,000. George B. Bright & Co., Marquette Building, are engineers.

Mich., Grand Rapids—The West Michigan Cold Storage Co. has tentative plans under way for the construction of an eight-story cold storage and refrigerating plant on local site, estimated to cost $250,000, including equipment. Work will be commenced in the spring. W. J. Breen, vice-president of the Home State Bank, Grand Rapids, is president.

Mich., Jackson—George E. Simpson, acting city manager, will receive bids until March 12, for one motor-driven centrifugal pumping unit, with control apparatus, capacity 7,000 g.p.m.

Mich., L'Anse—The Village Council contemplates the installation of electric-operated pumping equipment in connection with waterworks extensions and improvements to cost $54,000. Arthur G. Ohman is village clerk.

Mich., Port Huron—The Dunn Sulphite Paper Co. recently organized by Charles F. Bornman, 680 Delaware Avenue, Detroit, and associates, plans for the construction of a boiler plant at its proposed local paper mill, estimated to cost $250,000. Billingham & Cobb, Press Building, Kalamazoo, Mich., are engineers.

Minn., Minneapolis—The State Board of Control, Capitol Building, St. Paul, Minn., will receive bids until March 11, for water-tube boilers and mechanical stokers for the steam power house at the local University of Minnesota. The Charles L. Pillsbury Co., St. Paul and Minneapolis, is engineer.

Minn., Wadena—The Chippewa Sugar Refining Co., Grand Street, Milwaukee, Wis., plans for the construction of a boiler plant at its proposed local mill.

Minn., Winona—The City Council has voted to postpone temporarily the purchase of equipment for sewerage system service,

including centrifugal pumps, float switches, motors, auto starters, etc., and will place orders at a later date. E. E. Chadwick is city engineer.

Mo., Ava—The Nelson Canning Co. is planning for the installation of a boiler, engine and auxiliary equipment at its power house. Roy Nelson is head.

Mo., Hannibal—The City Council is considering the installation of electric-operated pumping machinery in connection with extensions and improvements in the municipal waterworks, estimated to cost $400,000. Plans will soon be completed. The Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., is engineer.

Mont., Livingston—The City Council has plans under consideration for the installation of electric-operated pumping equipment in connection with a municipal waterworks project to cost $45,000. Harry M. Shelver is city clerk.

Mont., Livingston—The Northern Pacific Railroad Co., is considering plans for enlargements in the boiler plant at its local repair shops in connection with proposed additions to cost about $300,000, including equipment.

Neb., Hastings—The Common Council has tentative plans under advisement for the installation of a municipal electric power plant, to be operated in connection with waterworks. A. T. Bratton is city clerk. P. T. Naylor, Hastings, is engineer.

Neb., Primrose—L. H. Whitman, city clerk, will receive bids until March 6, for equipment for the municipal waterworks, including one motor-driven deep-well pump, with capacity of 75 g.p.m.; pumping station and auxiliary equipment; 50,000 gal. capacity steel tank, on 60 ft. tower. The Henningson Engineering Co., National Building, Omaha, Neb., is engineer.

Nev., Carlin—The County Commissioners have authorized the installation of additional equipment in the local electric plant, including new boilers, 150 hp. Diesel engine and auxiliary apparatus, with switchboard.

N. J., Orange—The City Commission is considering recommendations made by Fred Luthy, chief engineer at the municipal electric plant, for the installation of a turbo-generator and auxiliary equipment to cost approximately $30,000. George Roach, director of streets and public improvements, is in charge.

N. J., South Orange—The Metropolitan Ice Co., 633 West Forty-seventh Street, New York, has acquired the local ice-manufacturing plant of the Lermann Hygeia Ice Co., and plans for extensions and installation of additional equipment to develop a capacity of about 60 tons per day, as compared with present rating of 30 tons.

N. J., Whitings (Ocean County)—The Bamberg Lake Corporation, recently organized by Joseph Parisi and associates, to develop a local industrial city, to be known as Roosevelt City, has tentative plans under consideration for the construction of a central power house, with pumping station for waterworks service.

N. Y., Albany—The Albany Perforated Wrapping Paper Co. plans to commence work in about 60 days on its proposed pulp mill at Sheet Harbor, N. S., where a large tract of timber property recently was acquired, to include a power house. The project will involve in excess of $225,000.

N. Y., Jamaica—The Board of Managers, Mary Immaculate Hospital, is considering plans for the construction of a boiler plant at the proposed ten-story institution to be erected at Skelton Avenue and Ray Street, to cost about $1,500,000. William J. Boegel, 195 Madison Avenue, New York, is architect.

N. Y., Medina — The City Council has called a special election on March 18, to vote bonds for $50,000, for extensions in the waterworks, to include the installation of an electric-operated pumping plant in the city Park district, on Oak Orchard Creek.

N. Y., New York—The Horn & Hardart Co., 600 West Fiftieth Street, will install oil-burning power equipment at its new four-story baking plant to be constructed at Eleventh Avenue and Fiftieth Street, estimated to cost $500,000. The foundations will be arranged for the addition of four more stories later. F. P. Platt & Brother, 680 Fifth Avenue, are architects.

N. Y., New York — The United States Navy Purchasing Office, South and Whitehall Streets, will purchase 214 mechanical and mercurial thermometers, as called for in N. S. A. req. 428.

N. C., Chimney Rock — The Chimney Rock Mountains, Inc., recently organized to develop a mountain resort in this section, plans for the construction of a hydro-electric power plant, with dam on the Rocky Broad River. The initial capacity will approximate 2,000 hp. E. S. Draper, Charlotte, N. C., is engineer.

N. C., Gastonia—The Spencer Lumber Co. is said to be considering plans for the rebuilding of its mill and boiler house, recently partially destroyed by fire with loss estimated at $80,000, including equipment.

N. C., Hemp—The County Moore Mills, Inc., plans for the construction of an electric power plant at its proposed local textile mills, to cost in excess of $150,000. Lockwood, Greene & Co., Charlotte, N. C., are architects and engineers.

N. C., Henderson—The Henderson Cotton Oil Mill is reported to be planning for the rebuilding of the portion of its boiler plant and cotton-seed oil mill, destroyed by fire, Feb. 14, with loss approximating $200,000, including equipment.

Ohio, Akron — The Board of Directors, People's Hospital, will construct a one-story boiler house at the proposed institutional buildings on West Cedar St., to cost in excess of $150,000. George Ball, Metropolitan Building, is architect.

Ohio, Circleville—The Columbus Railway, Power & Light Co., Columbus, has acquired the Barcus property in Harrison Township, totaling about 400 acres, and is said to be planning to use a portion of the site for a new steam-operated electric generating plant. It will be situated on Big Water Creek.

Ohio, Cleveland — The Ohio Confection Co., 5305 Sweeney Avenue, will build a boiler house at its proposed four-story and basement plant on the Warner Road, estimated to cost $250,000, on which work will be commenced early in the spring. The Dresser & Minton Co., 1082 Arcade, is architect and engineer. J. Friedman is president.

Ohio, Cincinnati—The Davis Welding & Mfg. Co., 1110 Richmond Street, is considering the construction of a boiler house at its proposed local plant, estimated to cost $100,000. Lockwood, Greene & Co., 38 South Dearborn St., Chicago, Ill., are architects and engineers.

Ohio, Findlay—William J. Altmeyer, head of the Krantz Products Co., is having plans drawn for the installation of an ice-manufacturing plant in the company's building at Clinton Court and Jefferson Streets. It is proposed to organize a new company to operate the property.

Ohio, Norton Field—The United States Army Department, Washington, D. C., has authorized the installation of a local water supply system, with pumping equipment, etc., for which bids will be asked in the near future by the constructing quartermaster.

Okla., Duncan—The Southwestern Light & Power Co., has negotiations in progress for the purchase of the local municipal power plant, and proposes to consolidate with its properties. Extensions will be made in this district.

Okla., Lawton — The Common Council plans for the installationof el ectric-operated pumping machinery at the proposed sewerage disposal plant, for which tentative plans have been prepared by H. G. Olmstead & Co., 2230 Eighteenth Street, Oklahoma City, Okla., engineers.

Okla., Newkirk—The City Commission has tentative plans for the installation of electric-operated pumping machinery in connection with proposed extensions in the waterworks, estimated to cost $100,000.

Okla., Oklahoma City—The City Council has plans nearing completion for waterworks extensions, including electric-operated pumping machinery, power dam extensions, and operating equipment, estimated to cost $1,900,000. Bids will soon be asked. B. M. Hart is city engineer.

Ore., St. Helens—The Columbia Lumber Co. is considering the construction of a boiler plant at its proposed lumber mill on local site, designed for an output of 80,000 ft. per day.

Pa., Hazleton — Richard Miller, Hometown, Pa., plans for the construction of a boiler plant at his proposed saw and lumber mill in the Locust Mountain section.

Pa., Grove City—The Common Council has superstructure work in progress on the proposed municipal electric plant, and plans for the installation of equipment at an early date.

Pa., Langhorne — The Philadelphia Suburban Gas & Electric Co., Philadelphia, has acquired the local plant and system of the Langhorne Electric Light & Power Co., and will merge with its properties. Extensions are planned.

Pa., Pittsburgh—The Pearl Laundry Co., 2015 Wyandotte Street, has tentative plans for the rebuilding of the portion of its boiler house and mechanical laundry plant, destroyed by fire, Feb. 21, with loss approximating $125,000, including equipment. Benjamin Mann is president.

R. I., North Smithfield — The Amedee Prouvost Co. of France, care of Lockwood, Greene & Co., 24 Federal Street, Boston, Mass., architects and engineers, plans for the construction of a boiler plant at its proposed local wool-combing mill, estimated to cost in excess of $750,000, with equipment.

S. C., Greenville—The Board of Directors State College of Agriculture and Engineering, is considering the erection of a new steam power plant at the institution, with capacity of about 1,000 hp.

S. D., Aberdeen—The City Trustees have plans under advisement for the installation of an electric-operated pumping plant and 1,000,000 gal. reservoir for municipal service. L. W. Kohlhoff is city clerk.

S. D., Stratford—The Common Council plans for the installation of electric-operated pumping equipment at its proposed waterworks plant.

Tenn., Erin—The Erin Utilities Co. plans for the installation of crude oil burning engine units at its power house, and has inquiries out for information on equipment of this character.

Tenn., Greeneville—The Common Council contemplates the installation of electric-operated pumping machinery in connection with extensions in the waterworks and sewerage system, for which bonds for $45,000 have been voted.

Tenn., Memphis—The Mississippi River Commission, 1006 McCall Building, will take bids until March 14, for one horizontal boiler and one boiler feed pump, as specified in Circular 24-33. Also, at the same time, for one centrifugal sand pump and engine, as set forth in Circular 24-34.

Tex., Collinsville—The Common Council has tentative plans under advisement for the installation of a municipal power plant. Bonds will be voted.

Tex., Lubbock—The Lubbock Power Co. has completed plans and will commence the immediate erection of an addition to its local power plant. A contract for the building work has been let.

Tex., Stanton—W. W. Williams, Stanton, is organizing a company to install an irrigation system in this vicinity. The installation will include electric-operated pumping equipment.

Va., Coeburn—The Chero-Cola Bottling Co. plans for the installation of an ice-manufacturing plant at its proposed local bottling works. T. B. Hillman is general manager.

Va., Wise City—The Common Council is arranging to secure a fund of $135,000, for the proposed municipal waterworks and sewerage system, to include the installation of electric-operated pumping equipment.

Wash., Centralia—The City Council plans for the construction of a pumping plant in connection with a proposed waterworks, using a supply from the Skookoumchuck River, for which permission has been granted, estimated to cost $100,000. Plans will be drawn in the near future.

Wash., Seattle—The Puget Sound Pulp & Paper Co. plans for the erection of a boiler plant at its proposed pulp and paper mill on site near the city, estimated to cost close to $5,000,000, with machinery.

Wis., Allouez (P. O. Superior) — The Town Council is considering the installation of electric-operated pumping equipment in connection with a waterworks system. A meeting to discuss the project will be held on March 15. Joseph Ducharme is town clerk.

Wis., Boscobel—The Common Council has preliminary plans under consideration for the construction of a new municipal lighting station, to replace the present installation.

Wis., Centuria—The Common Council is considering the installation of an electric-operated pumping station in connection with the proposed municipal waterworks and sewerage system. Druar & Milinowski, Globe Building, St. Paul, Minn., are engineers.

Wis., Neenah—The City Council has tentative plans under way for the construction of an electric generating plant at the municipal waterworks. C. A. Chapman, 28 East Jackson Boulevard, Chicago, Ill., is engineer.

Wis., Washburn — The Lake Superior District Power Co., has acquired the local plant and system of the Washburn Lighting Co., and will consolidate with its properties, operating at this location in the future.